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Microcomputers and the Electrical Engineer.

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University of Kansas

MICROCOMPUTERS AND THE ELECTRICAL ENGINEER

BY

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by

James Russell Hague

Submitted to the Department of Electrical & Computer Engineering in partial fulfillment of the requirements for the Master of Science Degree in Electrical Engineering

University of Kansas

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Thesis Committee:

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Professor Dale Rummer

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Professor Gerry Kelly

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Abstract

Computers are an important asset to the field of electrical engineering. The use of computer systems assists the electrical engineer in his endeavor to examine and solve complex problems. The lack of access to these machines inhibits this same electrical engineer in applying his analytical capabilities in developing solutions to these complex problems.

One restraint to the individual electrical engineer's use of all but the most basic computer systems has been the capital investment required to purchase these machines. This large initial financial obligation placed severe limitations on the access the electrical engineer could reasonably expect to have to a computer system. Unless the engineer was fortunate enough to work for a company that could afford to make this investment, he had to "make do" with little or no computing power to assist him.

Today, with the proliferation of microcomputer systems and their associated software, the electrical engineer has access to computing power that requires a relatively small initial investment. Because of the popularity of these microcomputer systems, untold man-years of effort are being expended in developing software for these machines. The individual electrical engineer can not efficiently compete with this effort and must learn to apply the results of these programmer's efforts in adapting software to his specific needs. Through the use of his imagination and his developed analytical skills, the electrical engineer can make efficient use of the microcomputer in his profession as both a "stand-alone" computer or as an interface to the much larger mainframe systems.

This thesis describes the legal aspects of software usage in the educational environment and some of the engineering applications of the microcomputer and its associated software. The usage of wordprocessing and spreadsheet applications in electrical engineering are discussed with specific applications demonstrated.

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Chapter 1

Legalities of Software Duplication

Any discussion of microcomputers will, sooner or later, lead to the topic of whether or not copying of software is permissible. A host of questions will be generated and opinions will be offered from all directions about the rights and privileges of educational institutions to copy and distribute software for educational purposes. Because universities will always have limited resources with which to purchase computer hardware and software, most discussions will attempt to find ways to stretch the academic dollar as far as possible. It is important that these discussions are based on fact and that legal agreements have been made with manufacturers of software before any proliferation of copyrighted material is allowed.

Because this is such a relevant and important topic to this paper, research in the area of the legalities of copying computer software for educational purposes has been included as Appendix A. The article in Appendix A was taken in its entirety from the November 1983 Personal Computing magazine. This article provides a background discussion on the 1976 Copyright Act and explains how this legal document was specifically written to protect computer software. The

article also discusses the definition of "fair use" in the educational environment and how it applies to classroom use of software. It poignantly points out that the "noble aims of scholarship do not provide educators with any privileged exception to this law." The report in Appendix A goes on to discuss the topics of library liabilities pertaining to software and the use of software in network connections. This article provides a very good foundation in the attempt to understand the legalities of usage with respect to computer software in the educational environment. It should serve as mandatory reading for anyone considering the use of software in education.

Further, as part of Appendix A, a sample letter has been included. This letter was addressed to different software companies requesting use of their product for this research project. A typical manufacturer's response is included which clearly shows what these companies reasonably expect in terms of copyright restrictions. These conditions must be met before the educational institution is allowed to begin wholesale use of copyrighted material in the classroom or other educational environments. Discussions with several other software manufacturers indicated that they are willing to provide significant educational discounts to any university so that these products can be used in the classroom. In return for these financial concessions, software companies will require that "legal care" be taken

to ensure that the usage of their products will not violate copyright laws. Should these licensing agreements be violated, it is reasonable to assume that the software manufacturer would seek monetary compensation from the parties responsible.

Chapter 2

System Definition

This project required the purchase of a microcomputer so that various software programs could be investigated for their adaptation to electrical engineering. Because there are a significant number of microcomputers available to choose from, the engineer must be willing to expend his time to research the various components and ensure that his choice will meet both his short range and long range goals.

The "golden rule" in purchasing a computer is to find the software that an individual wants to run and then find the microcomputer that will run those programs. Because of the approach this paper took, it was impossible to follow this rule. Therefore, research was done on computer hardware systems with the idea that any computer chosen for this project must accommodate the largest array of software the marketplace had to offer.

Appendix B is a report that was completed for another class. Based on the research that was done to produce this report, it was determined that the IBM Personal Computer offered the greatest quantity of software and hardware support available for microcomputers. Thus, it was logically assumed that the IBM PC would offer the greatest flexibility

with which to work with during this research project.

The microcomputer system used in this research project included the IBM PC central processing unit with 256K RAM of memory, dual floppy disk drives, color monitor with graphics card, serial and parallel port, real time clock, memory expansion card with total system memory of 640K RAM, and a 8087 math coprocessor. Two printers were chosen to minimize cost yet maintain maximum flexibility. The Okidata 93 dot-matrix wide-carriage printer provided graphics print capability and the Dynax DX-15 daisy wheel provided letter quality printing.

It should be noted that although the basic IBM PC unit was purchased from IBM, the add-on boards and other components used in the research project were bought from third party sources because; 1) significant savings were realized by using this approach and 2) more options could be included than had the system been a "pure" IBM PC. Appendix B provides further explanation of why these third party components are so readily available and why this improves the marketability of IBM's personal computer.

Chapter 3

Word Processing

Of all the repetitive functions required of an electrical engineer, none can be more clearly guaranteed than that of generating reports. From the simplest memo to the most complicated multi-volume document, the requirement to produce effective written communication will follow every engineer from entry level to the most senior management positions. In a survey that was done by Consumer Reports, of the professionals surveyed who owned microcomputers, "75 percent"[1] of them used the computer for word processing. This clearly indicates that the microcomputer can quickly lend itself to the task of producing written documents that can be easily modified, formatted, and checked for spelling accuracy.

Although word processing software varies in what each "package" can do, the basics usually include automatic carriage return (called word-wrap); justification of margins; add, delete, or move letters, words, sentences, or blocks of text, with extensive retyping eliminated because of electronic reformatting capability. Advanced functions include search features to locate and replace words; allow superscript, subscript, boldface, and underlining

capability; provide automatic page headings, and generate page numbers; merge information from two or more files; and electronically flag grammatical and spelling errors. Consumer Reports states that this list gives an indication of why "Word-processing was the single most consequential computer application for the Consumer Reports readers we surveyed who already own a personal computer, and the one with which they were most satisfied."[2]

From the electrical engineer's point of view, the word processing package can be used to reduce the amount of time documenting his design efforts. Block diagrams, wiring lists, parts lists, and timing diagrams can be easily generated on the word processor and repeatedly modified and updated as required. An added advantage is that "permanent" records can be saved to disk and adapted to future design work. All of these functions will assist the engineer in providing quality documentation with his design efforts.

The original intent of this research paper was to evaluate different word processing packages for their adaptability to the field of engineering. After research was started, it was quickly determined that the capabilities of most word processing packages were comparable in the functions provided. Also, a very comprehensive review manual, The Ratings Book, written by Software Digest, Inc. provides a unique evaluation system to test comparable software packages. Software Digest's thorough testing

provides excellent benchmark test results with which to compare the major categories of software. Because of copyright restrictions, none of Software Digest's results could be reprinted here; however, it is recommended that this informative book be consulted for the information required to make a decision on which software package best fulfills a specific microcomputer application.

In the educational environment, cost would be a major factor in the decision of which word processing system to use for multiple student application. Micropro provides a significant discount to universities so that their software products will be available for educational purposes, (see Appendix A for further information). Micropro also has one of the best word processing programs in their Wordstar program. In fact, Dennis P. Curtin reports in his Wordstar Handbook that "Wordstar has established itself as the most popular word processing program for personal computers, such as the Apple and IBM. The reason it is preeminent in a crowded field is simple. Wordstar is so powerful and flexible that you can do almost anything with it."[3] Based on these two facts alone, Wordstar should be close to the top of the list for any university considering purchasing word processing for classroom use.

Two word processing packages were used to develop this section of the research paper. Peachtext 5000 and, as previously mentioned, Wordstar. Peachtext 5000 is a product

of Peachtree Software Incorporated and includes word processing, spell proofreader, Random House Electronic Thesaurus, list manager, and PeachCalc Electronic Spreadsheet. It should be noted that these Peachtext programs are, as Stevanne Ruth Lehrman reported in her Byte magazine article, "Peachtext 5000", "confederated--not integrated--into one package"[4], even though they use the same main menu. This means that although a number of programs are included, there is only limited interaction between the different components of the software package. Miss Lehram went on to point out that the major flaw with Peachtext 5000 is its documentation. She states: "As I said earlier, bad documentation is a preventable crime. With an index, better organization, and a readable layout, the manuals would be infinitely more usable."[5] Wordstar, quite to the contrary, doesn't suffer from bad documentation. In fact, because Wordstar has become such a popular software package, third party documentation for Micropro's word processing program has grown into a small industry.

During my usage, it was found that both Peachtext 5000 and Wordstar provided considerable word processing power. Each package allowed the flexibility to "overcome" hardware/software incompatibilities. However, because of significant third party documentation, user-friendly screen layout while in a "text" mode, superior spelling program, and user control of default settings, Wordstar was preferred

over Peachtext 5000. As practice increased the user's knowledge and confidence, Wordstar allowed greater flexibility and control of program "default settings" than did Peachtext 5000 word processing. This was considered very important in "defining" the software the way an engineer might want the program configured. No complicated design schematics could be generated with word processing programs since Wordstar, as well as other word processing programs, have no special fonts or symbols necessary for circuit layout.

The following is a demonstration of word processing software and hardware (a specialty printer wheel) which gives the engineer the capability to develop engineering or mathematical formulas or notation that can be used throughout a text. These specialty wheels are relatively inexpensive and available for a wide variety of daisy wheel printers now available through the retail market. Wordstar and Peachtext 5000 provide for the use of these special print wheels in each of their respective software programs.

$$i(t)=i(t_o)e^{-(R/L)(t-t_o)} + e^{-(Rt/L)}\int_{t_o}^{t} e^{-(Rq/L)}V/Ldq$$

Several software companies are working on soon to be released word processing programs that will have special

font files containing standard math and engineering symbols that can be utilized with dot-matrix printers but, for complicated drawings or design symbology, the use of specialized programs will still be required.

The following pages demonstrate projects that were produced on Wordstar and Peachtext 5000. Block diagrams and tables were easily generated and printed without difficulty. These completed projects were printed on a Dynax, DX-15, daisy wheel printer using a standard print wheel. Again, if necessary, special font wheels are available for printers so that mathematical equations can be printed out.

Also, a specialized form is included to show the versatility of wordprocessing. Peachtext 5000 was used to develop the form included on page 41. Several printing companies were contacted and requested to quote a price for the cost of developing this form. The prices ranged from $180.00 to $365 for 150 copies to 300 copies for a two-part form. By using standard company letter head and development of this form, one hour was required to set the form up on the computer. A program was then developed using data-base to fill in the blanks on the form and keep a "disk record" of acknowledgments. This required an additional hour of work. By using the computer and its programs, the requirement for a multi-copy form was eliminated thereby reducing paperwork and reducing costs to a total of $60.00 for 150 copies.

Notes

[1]"The Computer as Super-Typewriter", Consumer Reports, October 1983, p. 540

[2]"What Home Computers Can Do", Consumer Reports, September 1983, p. 464

[3]Dennis P. Curtin, "Introduction", Wordstar Handbook, (New York Van Nostrand Reinhold Co., 1983), p. vii

[4]Stevanne R. Lehrman, "Peachtext 5000", Byte Magazine, April 1984, p. 186

[5]Ibid., p. 202

Wordstar

Example File

EE-641

Design Project 3

James R. Hague

202514

MINI - DESIGN PROJECT 3

I. PRINCIPLES OF OPERATION

A. Description:

The purpose of this project is to design a circuit that will estimate the speed of an object, to the nearest .1 meter/second, moving past a pair of sensors. The sensors are spaced one-meter apart and only one object at a time will pass in front of the sensors. The objects will have a speed no slower than 10 meter/second and no faster than 60 meter/second.

B. Truth Table:

The partial truth table is shown in Figure 1. A complete computer generated truth table would be developed in actual practice for use in programming a readable memory.

II. CIRCUIT DESCRIPTION

Figure 2 illustrates the circuit in block form. The circuit was implemented using the new 74LSECE641-B-JRH chip. The 74LSEECE641 is a basic reciprocal function with the B representing BCD output. The JRH, of the part number, represents a scale factor of 400. The counter used the cascadeable SN74LS136AN's along with one SN74LS27N NOR gate for counter control. The counter will be manually reset to 00.0 and once enabled by an object passing sensor A, will generate pulses at 40KHz until the object passes sensor B, which will stop the count. The count will provide a binary input to the reciprocal function which will in turn display the resultant average velocity of the object in BCD form.

III. DESIGN CALCULATION

Based on a maximum speed of 60 meter/second, elapsed time 16.667 milliseconds, and 59.9 meter/second, elapsed time 16.695 milliseconds, a difference of 27.82 microseconds was determined to be the maximum pulse duration to ensure .1 meter/second accuracy. A 25.0 microsecond pulse duration was chosen thus requiring a 40KHz clock. With this clock 4,000 pulses were counted at the slowest speed of 10.0 meter/second (Figure 1).

Based on the above calculations, the binary counter requires, a log 4000/log 2 = 12 bits, (Figure 3).

IV. SIGNAL GLOSSARY

1. Inputs

CLOCK (H) = Masterclock (40KHz) state changes on rising edge

RESET (L) = Manual reset to 00.0 (Display)

START (H) = SENSOR A activates on leading edge of object (Start Count)

STOP (H) = SENSOR B activates on leading edge of object (Stops Count)

2. Outputs

BCD80 (H) = MSB = Data (BCD) = Tens x 8
A high level on this data bit represents acomponent velocity of 80 meters/second

BCD40 (H) = Data (BCD) = Tens x 4
BCD20 (H) = Data (BCD) = Tens x 2
BCD10 (H) = Data (BCD) = Tens x 1
BCD 8 (H) = Data (BCD) = units x 8
BCD 4 (H) = Data (BCD) = units x 4
BCD 2 (H) = Data (BCD) = units x 2
BCD 1 (H) = Data (BCD) = units x 1
BCD .8 (H) = Data (BCD) = tenths x 8
BCD .4 (H) = Data (BCD) = tenths x 4
BCD .2 (H) = Data (BCD) = tenths x 2
BCD .1 (H) = Data (BCD) = tenths x 1

V. BILL OF MATERIALS (Figure 3)

Ref no.	Part #	MFGR	Description
IC1-3	SN74LS163AN	T.I.	Synchronous 4-Bit Binary Counter
IC4	SN74LS27N	T.I.	(3) 3-input Positive Nor Gate
IC5	74LSECE641-B-JRH	KUECE	400/X BCD Output

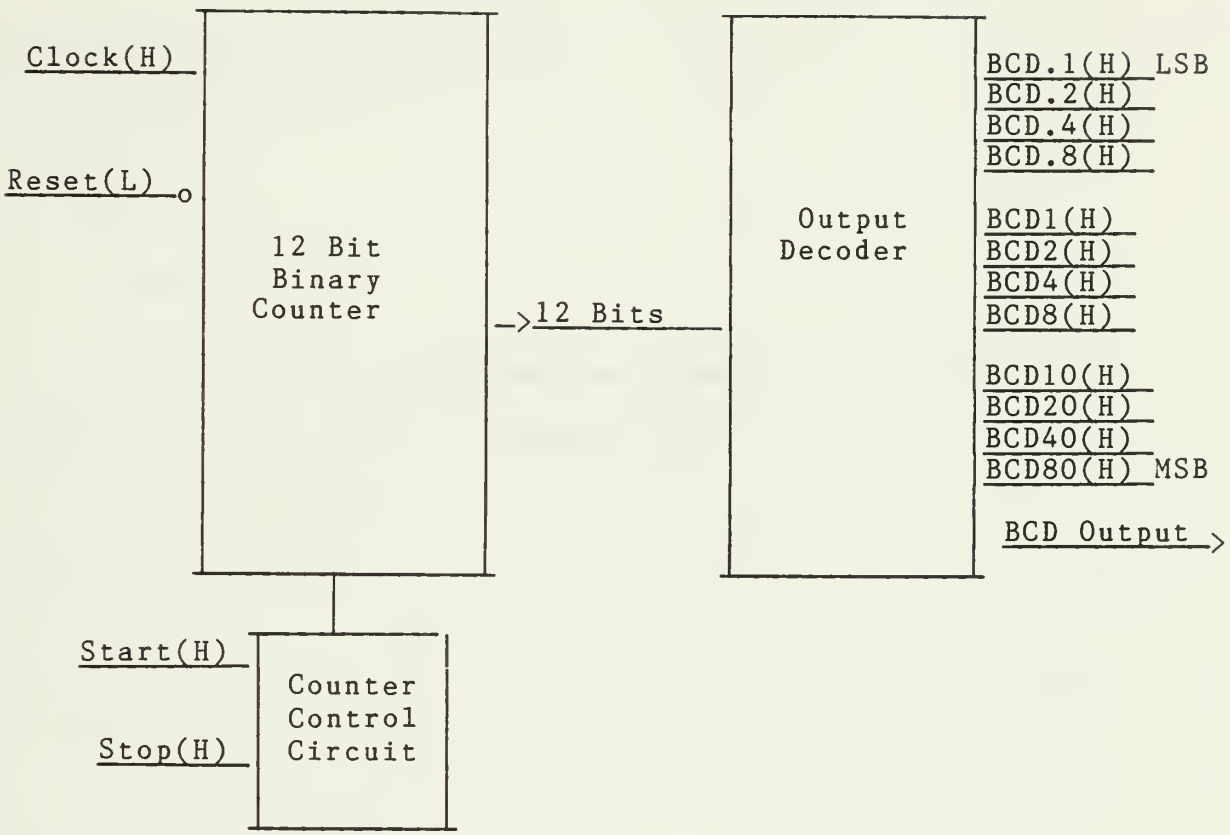
Abbreviated Truth Table

Object Velocity (Meter/Sec)	Elapsed Time (Millisecond)	Counter Output	74LSECE641-B-JRH Output Display
10.0	100.000	4000	10.0
10.1	99.009	3960	10.1
10.2	98.039	3921	10.2
10.3	97.087	3883	10.3
10.4	96.153	3846	10.4
10.5	95.238	3809	10.5
10.6	94.339	3773	10.6
10.7	93.457	3738	10.7
10.8	92.592	3703	10.8
10.9	91.743	3669	10.9
~	~	~	~
~	~	~	~
59.1	16.920	676	59.1
59.2	16.891	675	59.2
59.3	16.863	674	59.3
59.4	16.835	673	59.4
59.5	16.806	672	59.5
59.6	16.778	671	59.6
59.7	16.750	670	59.7
59.8	16.722	668	59.8
59.9	16.694	667	59.9
60.0	16.666	666	60.0

Design Project 3: Speed Estimator		
Drawn by: James R. Hague		Designer: James R. Hague
October 5, 1983	EE-641	

FIGURE 1

BLOCK DIAGRAM



Design Project 3:Speed Estimator		
Drawn by: James R. Hague		Designer: James R. Hague
October 5, 1983	EE-641	

Figure 2

Peachtext 5000

Example File

June 19, 1984

Dr. Josef Beidar
Canada Centre for Remote Sensing
2464 Sheffield Road
Ottawa, Ontario
CANADA K1A OY7

Dear Josef:

Attached is the preliminary proposal you requested for the scatterometer systems. Please note that strict adherence to the frequency specifications you provided will probably require some added engineering/hardware costs. In addition, the elevation positioning poses no problem; however, based on our experience, azimuth positioning is best achieved with the boom itself. For both elevation and azimuth positioning, there are additional bits in the controller/data acquisition system links which will allow for automatic positioning control.

I would also like to add that the preliminary cost figures may be slightly on the high side, but for planning purposes, it is always easier to scale-back than scale-up.

Should you have any further questions or require any more information from us, please don't hesitate to call.

Best personal regards,

Craig Robson

PRELIMINARY PROPOSAL

Microwave Scatterometer Systems

1.0 DESIGN CONCEPT

The series of Microwave Scattermoeter (MS) Systems manufactured by Applied Microwave Corporation are the result of over ten years of experience in this field. The MS series are FM-CW radar systems designed for the rigors of the field environment and for near-to-intermediate range applications (e.g., tower, truck, and helicopter platorms). The goal of Applied Microwave in offering the MS series is to provide reliable and high performance radar scatterometers which can be operated simply on a minimum maintenance basis over prolonged periods by either engineers or scientists.

The MS series is based upon a modular design concept wherein each system operates at a discrete frequency in order to optimize performance and reliability without sacrificing weight and cost. Standard designs are available at L-,C-, and X-bands; however, the modular design apporach allows for the construction of systems operating at any frequency from 1.5 to 50GHz with a minimum of engineering expense. Each single-frequency MS module can operate

independently or multiple modules can be linked for parallel operation using a common Data Acquisition System (DAS) and Controller.

Each radar system is a single frequency, single antenna FM-CW radar. It incorporates a stripline microwave integrated circuit whose performance is optimized at the radar's specific frequency. At frequencies above X-band, discrete components are used instead of a stripline circuit. The antenna is also optimized at the particular radar frequency. Antenna efficiency is typically .55 and the integrated cross-polorized gain is more that 25dB below the like-polorized product gain.

The spectum of the IF signal produced the the FM-CW radar is the returned power versus target range. By sampling the IF spectrum versus frequency, the target's range and back-scattering can be determined by the computer. No manual adjustment of the FM rate is required. Targets with finite range extent can be sampled versus range to determine the relative backscattering of each component within the target. Range resolution is approximately 5% of the nominal target range.

Depending upon user defined specifications of frequency, beamwidth, and polarization isolation, most modules are within the weight-load requirements of a boom-mount on a

pick-up truck (less than 50 pounds). For multifrequency applications, a heavier truck/boom system may be required. Boom-loading specifications for the user's mounting platform can be factored into overall system design should weight become a limiting factor. Applied Microwave also offers a low-cost series of elevation positioners for use with individual MS modules and multiple module applications. These positioners can be operated independently or automatically through the MS system controller.

The user interfaces with the operation of MS system via the controller. The controller is typically an HP-75 or HP-85 mini-computer which is programmable in BASIC. The controller functions to direct MS operations, record data, pre- and post-process data, and deliver real-time output of radar backscattering coefficient . Each MS system is delivered with control programs that allow a variety of common experimental data acquisition modes. Optional software is also available for added flexibility in post-processing of data and data display.

2.0 HARDWARE SPECIFICATIONS

The hardware specifications for MS systems at L,C,X, and

Ku-bands are given in Table 1 of this proposal. MS systems are not available at center frequencies below 1.5 GHz because ortho mode couplers are not manufactured below this frequency.

The controller can be either an HP-75 or HP-85 mini-computer. For most single-frequency appliations, the HP-75 is sufficient; howver, for single-frequency applications requiring a high sampling rate or for parallel operation of multi-module MS systems, the HP-85 controller is highly recommended due to increased speed and storage capacity. Both controller options are used to automatically sample and store the IF spectyrum as opposed to manual tuning of an IF filter window (range-gating). This feature dramatically increases system operating speed since no manual operator control is required to tune FM. Additional benefits of this feature are:

(1) Increased measurement speed since human error is removed and manual tuning errors related to signal scintillation (fading) are bypassed.
(2) Non-uniform range to target is automatically recorded, and
(3) The user has the capability to independantly examine multiple scattering centers within the target (e.g.,

canopy and soil background) within the limitations imposed by the 5% of range sampling windows.

The weight specifications for each frequency module are also given in Table 1 of this proposal. Most boom structures can readily hold three frequency modules. The recommended boom mounting technique is demonstrated in Figure 2. Generally, weight limitations are critical for the positioner rather than for the boom itself. As shown in Figure 2, weight loading on the positioner is reduced by mounting the DAS below the positioner plane. Optional elevation positioners (0 to 110) are designed for single- or multiple-frequency use and tailored to specific weight requirements. It is recommended that the boom itself be used to provide azimuth positioning unless tower-mounting is anticipated.

2.1 SYSTEM HARDWARE MATRIX

The following system configurations are treated in this preliminary proposal:

(1) MS/1.5 GHz plus MS/4.9 GHz (MS/L+C)

(2) MS/1.5 GHz plus MS/4.9 GHz plus MS/10.1 GHz (MS/L+C+X)

(3) MS/1.5 GHz plus MS/4.9 GHz plus MS/14.6 GHz (MS/L+C+Ku)

It is assumed that flexibility is desired to operate each frequency module independently on its own support boom or combined on a single mounting platform. Hence, each frequency module will require its own DAS, controller, and positioner for independent operation. For one frequency, a DAS (HP-3497) and controller (HP-85) capable of driving all MS modules simultaneously is provided. Each controller is provided with an RS-232 interface for data communications. In addition, the heavy duty positioner for the L-band system has been designed to handle the weight of all three frequency modules.

2.2 SYSTEM SOFTWARE

Each controller will be provided with identical software for single-frequency operation. The software will control the Radar opeation as well as record and store all data. An RS-232 port is provided for interfacing with other computer systems for mass data storage and transfer and final analysis. Standard output is also given as mean radar backscattering coefficient as averaged over a user selected number of samples. In addition, the HP-85 controller will

be supplied with software for combined multiple-frequency operation. Note that the mean value is referenced to periodic system calibration with respect to a point target of known radar cross-section. It is recommended that reflectors or Active Radar Calibrators (ARC) be used for this calibration.

Optional software is available through Applied Microwave Corporation for special requirements. In addition, there are excess bits in the which can be used to automatically control the elevation positioner.

3.0 COSTS

Preliminary cost estimates for the system configurations given in Section 2 are listed in Table 3. These cost estimates include all MS hardware (radar, DAS, controller, printer, and cassette recorder) listed for each configuration in Table 2 and also include appropriate manuals and software. Optional costs are also given for video camera/monitors, positioners, and Active Radar Calibrators at each frequency.

Frequencies other than those specified require additional engineering expense to optimize performance or entail added hardware costs. Estimated average cost

increments for non-standard center frequencies are $5,000 U.S. per MS system.

4.0 DELIVERY SCHEDULE

Delivery is approximately 260 days from receipt of order.

5.0 MAINTENANCE AND SERVICE

All hardware is designed for use in field environment and can be operated by personnel with little technical experience. Each MS system is carefully inspected and tested for system specifications. Factory determined calibration constants are supplied along with the documentation necessary to make field repairs in the event of malfunction. All components and workmanship are fully warrantied by Applied Microwave under normal useage conditions. In the unlikely event that factory servicing becomes necessary, items should be shipped prepaid to Applied Microwave Corportation.

RADAR SYSTEM SPECIFICATIONS

FREQUENCY:
L-Band---------- 1.5 GHz
C-Band---------- 4.9 GHz
X-Band----------10.1 GHz
Ku-Band----------14.6 GHz

BANDWIDTH: 300 MHz nominal

POLARIZATION: HH,HV,VH,VV

CROSS POLARIZATION ISOLATION: 25dB (minimum)

BEAMWIDTH(Product): L-Band--6 Degrees
All Others--3.5 Degrees

TRANSMIT POWER: 20mW

POWER SUPPLY: 110 VAC, 60 Hz, 200 Watts

RECEIVER DETECTION CENTER FREQUENCY: 22kHz

RECEIVER DETECTION BANDWIDTH: 1.1kHz

NOISE-EQUIVALENT MINIMUM DETECTABLE : -30dB for HH or VV
-40dB for HV or VH

CONTROLLER: Hewlett Packard 85 or 75
with printer cassette recorder

INTERFACE: Hewlett Packard Data Acquisition System

DATA RATE: 30 samples/second (HP-75)
100 samples/second (HP-85)

RANGE SAMPLING: 1 sample every 5% of range to target
30 range samples/data point

DATA REDUCTION: Mean Backscattering Coefficient versus Range

MECHANICAL DATA:

	SIZE	WEIGHT
L-Band	58" diameter dish 30" x 24" x 13"	115 pounds
C-Band	30" diameter dish 11" x 20" x 16"	56 pounds
X-Band	16" diameter dish 11" x 20" x 16"	53 pounds
Ku-Band	12" diameter dish 11" x 20" x 16"	48 pounds

TABLE 1

CONFIGURATION	HARDWARE
(1) MS/L+C	MS/L, HP-3497 Data Acquisition System, HP-85 Controller, printer, and cassette recorder MS/C, HP-3421 Data Acquisition System, HP-75 Controller printer, and cassette recorder
(2) MS/L+C+X	Same as (1) but add: MS/X, HP-3421 Data Acquisition System, HP-75 Controller, printer, and cassette recorder
(3) MS/L+C+Ku	Same as (1) but add: MS/Ku, HP-3421 Data Acquisition System, HP-75 Controller, printer, and cassette recorder

TABLE 2

COST (U.S. DOLLARS)

(1) MS/L+C

Radars, Data Acquisition Systems, Controllers, printers, cassette recorders, and software	$124,000
Two elevation positioners (one heavy duty)	$ 3,000
	$127,000

(2) MS/L+C+X or MS/L+C+Ku

Radars, Data Acquisition Systems, Controllers, printers, cassette recorders, and software	$176,000
Three elevation positioners (one heavy duty)	$ 4,000
	$180,000

(3) Options:

a. Non-standard frequencies	add	$ 5,000
b. Video monitor/camera		$ 600
c. Active Radar Calibrators (with battery pack and variable step attenuator)		
L-Band		$ 4,400
C-Band		$ 6,000
X-Band		$ 8,000
Ku-Band		$ 8,500

NOTE: All prices are quoted FOB Lawrence, Kansas

TABLE 3

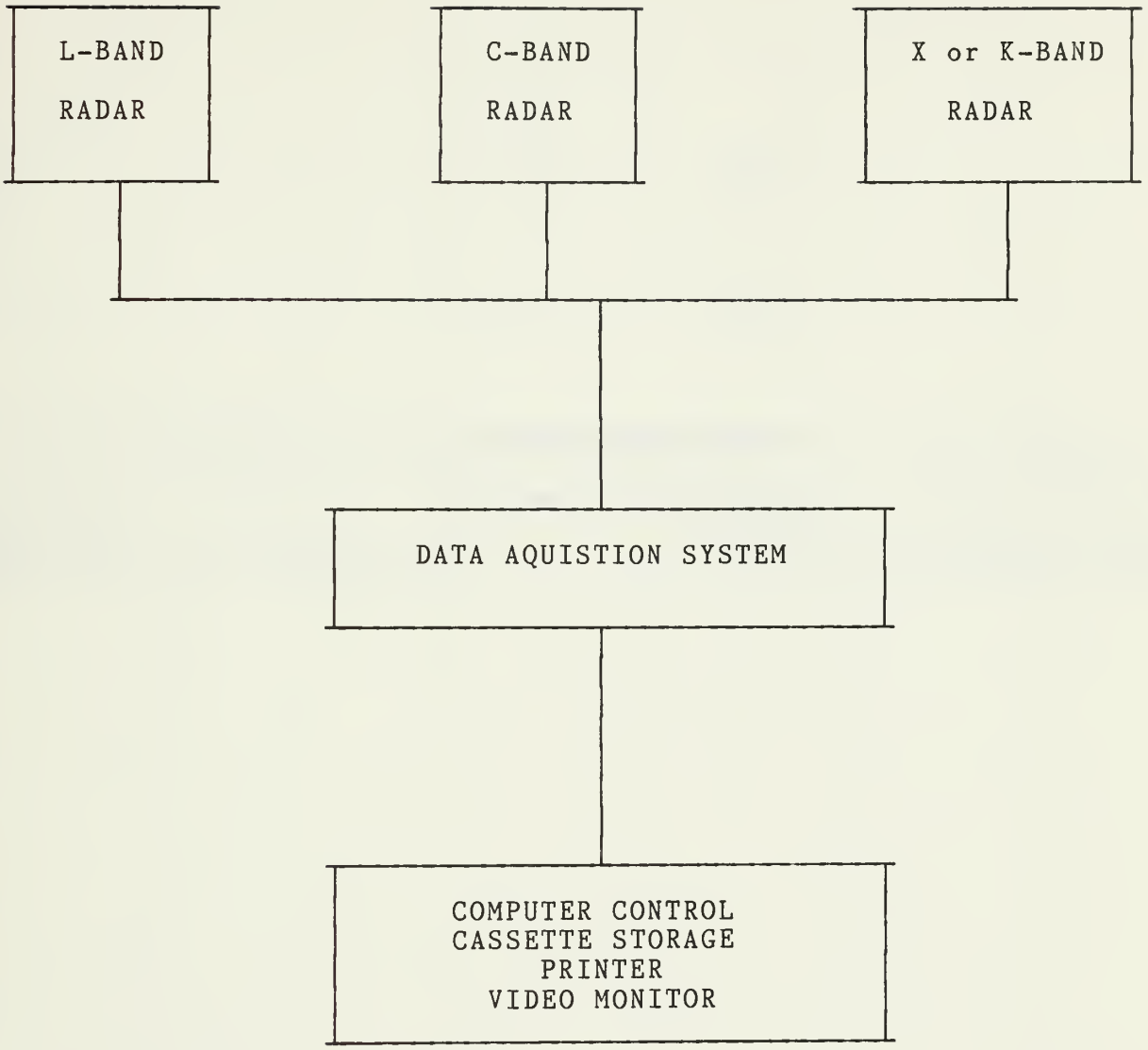

L-BAND
RADAR
C-BAND
RADAR
X or K-BAND
RADAR
DATA AQUISTION SYSTEM
COMPUTER CONTROL
CASSETTE STORAGE
PRINTER
VIDEO MONITOR

FIGURE 1

A Specialized Form

With Word Processing

ACKNOWLEDGEMENT

No.

SOLD TO	SHIP TO

Your Order Number:	Date Received:	Representative:	Terms: NET 30 Days
Resale [] Taxable [] Permit No: U.S. Gov't [] Out of State []	Ship Via:	Ship Chgs: Prepaid [] Collect []	F.O.B. & Title Pass Destination [] Shipping Point []

Quantity	Description	Est Ship Date	Unit Price	Amount

*** TOTAL COST ***

THIS ORDER ACCEPTED SUBJECT TO THE CONDITIONS ON REVERSE SIDE

CUSTOMER ACKNOWLEDGEMENT

Chapter 4

Spreadsheet

The electronic spreadsheet finds more direct application to the field of engineering than any other "general purpose" software available. These spreadsheet programs are more than just an "accountant's worksheet." This is because most spreadsheet programs that are marketed today include powerful mathematical, trigonometric, and logic functions. These functions can be utilized throughout the worksheet in modeling a specific engineering application. This model then becomes a permanent file that can be utilized over and over again in asking "what if" in the analysis process. Recently, graphics capabilities have been added to the electronic spreadsheet and this provides the engineer with a new dimension in utilizing these programs to assist him in the analysis of complex problems.

A spreadsheet program simplifies the amount of "programming" the engineer needs to know or do by limiting the calculations performed to a matrix of blocks. As further explanation, a spreadsheet program is a large array of columns and rows. The column's width is user defined so that varying sizes of numbers or formulas can be installed in the worksheet. This capability to customize the spreadsheet program allows freedom of application to

different type problems. The division of rows and columns are usually called "cells" or blocks where information (alphanumeric, numeric, or formula) may be stored and utilized in varying applications. The power of the spreadsheet comes from the fact that stored formulas can use as variables the numeric content of other cells. The content of any one block or cell is defined by the row and column that intersects at that variable's location. As an example of this application, the following figure demonstrates the defining of a cells location.

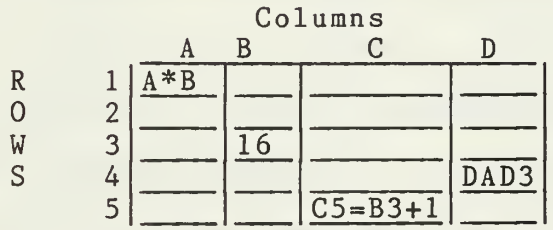


Figure 1: Spreadsheet

As can be seen from the above example, the label A*B is stored at location A1, the numeric value 16 is stored at location B3, the alphanumeric value DAD3 is stored at location D4, and the formula C5=B3+1 is stored at location C5.

The spreadsheet program that was utilized in developing this research paper was SuperCalc[3], which is a product of Sorcim Corporation. This spreadsheet is a 63 x 254 (column by row) grid that can have a variety of information stored

in each cell. Commands such as "replicate", "copy", "arrange", "insert", "window", "delete", and "format" make the entering and correcting of complicated formulas relatively easy to accomplish.

Included in Sorcim's spreadsheet program is the capability to graph different functions and data as they are generated. The graphics program supports a wide array of plotters and graphics printers and allows for user customization. In fact, whether it is the spreadsheet program or the graphics package, Sorcim has allowed the user the important option of maximizing the software to hardware interface for a particular system.

The following figures demonstrate some of the mathematical capabilities of the spreadsheet program. Figure 2 shows a program that performs different operations on two numbers that have been stored in locations B2 and B3. It should be noted that some of the calculations also involve values from other locations. Figure 3 represents the exact same spreadsheet only this time the contents of each location has been printed out. This allows the user to see what formulas have been placed in a cell that would normally display calculated results. Figure 4 is an example of Figure 2 with the values of location B2 and B3 changed. The printout shows all the new calculated values for each of the formulas listed. The user has control of calculations so the display will automatically recalculate all rows and

columns or recalculate incrementally at the user's discretion. This user option will allow data to be analyzed as a "process" occurs and corrections can be made as required. This would seem to be a very useful option in monitoring a customized program the first time through.

	A	B	C	D
1	EXAMPLE			
2	1st Number	20	SUM(B2:B6)=	242
3	2nd Number	10	AVERAGE(B2:B6)=	48.4
4	B2*B3=	200	MIN(B2:B6)=	2
5	B2-B3=	10	MAX(B2:B6)=	200
6	B2/B3=	2	PWR=20LOG(B2/B3)	6.02059991327962
7	SQRT(B2)=	4.47213595499958	IF(B2=B3,25,-15)=	-15
8	SQRT(B3)=	3.16227766016838	IF(B2<=B3,B4,B5)=	10
9	SQRT(B2*B3)=	14.1421356237310	B2^B3=	10240000000000
10	SQRT(B3/B2)=	.707106781186548		
11	LOG(B2)=	1.30102999566398		
12	LOG(B3)=	1		
13	EXP(B3)=	22026.4657948067		
14	LN(B2)=	2.99573227355399		
15	INT(B7)=	4		
16	ABS(B2)=	20		
17	MOD(B2,B3)=	0		
18	ROUND(B2,1)=	20		
19	SIN(B2)=	.912945250727628		
20	PI*B3=	31.4159265358979		
21	ASIN(B19)=	1.15044407846124		

Figure 2

	A	B	C	D
1	EXAMPLE			
2	1st Number	20	SUM(B2:B6)=	SUM(B2:B6)
3	2nd Number	10	AVERAGE(B2:B6)=	AVERAGE(B2:B6)
4	B2*B3=	B2*B3	MIN(B2:B6)=	MIN(B2:B6)
5	B2-B3=	B2-B3	MAX(B2:B6)=	MAX(B2:B6)
6	B2/B3=	B2/B3	PWR=20LOG(B2/B3)	20*LOG(B2/B3)
7	SQRT(B2)=	SQRT(B2)	IF(B2=B3,25,-15)=	IF(B2=B3,25,-15)
8	SQRT(B3)=	SQRT(B3)	IF(B2<=B3,B4,B5)=	IF(B2<=B3,B4,B5)
9	SQRT(B2*B3)=	SQRT(B2*B3)	B2^B3=	B2^B3
10	SQRT(B3/B2)=	SQRT(B3/B2)		
11	LOG(B2)=	LOG(B2)		
12	LOG(B3)=	LOG(B3)		
13	EXP(B3)=	EXP(B3)		
14	LN(B2)=	LN(B2)		
15	INT(B7)=	INT(B7)		
16	ABS(B2)=	ABS(B2)		
17	MOD(B2,B3)=	MOD(B2,B3)		
18	ROUND(B2,1)=	ROUND(B2,1)		
19	SIN(B2)=	SIN(B2)		
20	PI*B3=	PI*B3		
21	ASIN(B19)=	ASIN(B19)		

Figure 3

	A	B	C	D
1	EXAMPLE			
2	1st Number	38	SUM(B2:B6)=	1521
3	2nd Number	38	AVERAGE(B2:B6)=	304.2
4	B2*B3=	1444	MIN(B2:B6)=	0
5	B2-B3=	0	MAX(B2:B6)=	1444
6	B2/B3=	1	PWR=20LOG(B2/B3)	0
7	SQRT(B2)=	6.16441400296898	IF(B2=B3,25,-15)=	25
8	SQRT(B3)=	6.16441400296898	IF(B2<=B3,B4,B5)=	1444
9	SQRT(B2*B3)=	38	B2^B3=	1.07591180198e60
10	SQRT(B3/B2)=	1		
11	LOG(B2)=	1.57978359661678		
12	LOG(B3)=	1.57978359661678		
13	EXP(B3)=	3.18559317571e16		
14	LN(B2)=	3.63758615972632		
15	INT(B7)=	6		
16	ABS(B2)=	38		
17	MOD(B2,B3)=	0		
18	ROUND(B2,1)=	38		
19	SIN(B2)=	.296368578709384		
20	PI*B3=	119.380520836412		
21	ASIN(B19)=	.300888156922467		

Figure 4

The following pages demonstrate only a few of the many applications that can be done utilizing the spreadsheet program. It should be remembered that if the electrical

engineer uses his microcomputer and spreadsheet program, he will be able to build files of customized spreadsheet programs to model circuits and ask the question "what if". Over a period of time these files would grow, if utilized, and be of tremendous asset to the engineer in his daily design efforts. Should this engineer ever move into management, his knowledge and use of the spreadsheet program could continue to be an asset to him in analyzing management data.

Sine Wave Generator

The following example demonstrates the use of a spreadsheet program to generate a sine wave. Figure 1 shows the formulas that were "loaded" into the spreadsheet. The user has control over amplitude of the signal (cell B3), fundamental frequency (cell B4), Y-axis intersect (cell B5), and time increments (cell B6). Time increments could be made smaller and this would improve the number of data points for graphics. Figure 2 shows the data output, and Figure 3 and 4 show graphics representation of the Sine wave. Although this is a trivial example, it should be clear that with the trigonometric capabilities of the spreadsheet program, it is possible to sum complex functions and graphically display the results. This could be done ad infinitum to present different results of alternating current waveform.

	A	B	C
1	Sine Wave		
2	---	---	---
3	zero deg coef	10	
4	frequency (r/s)	377	
5	1st value of t	0	
6	time increment	.001	
7	---	---	---
8	Voltage	B5	10*SIN(B4*B8)
9	Time (rad/msec)	B8+B6	10*SIN(B4*B9)
10	60Hz Sine Wave	B9+B6	10*SIN(B4*B10)
11	Figure 6	B10+B6	10*SIN(B4*B11)
12		B11+B6	10*SIN(B4*B12)
13		B12+B6	10*SIN(B4*B13)
14		B13+B6	10*SIN(B4*B14)
15		B14+B6	10*SIN(B4*B15)
16		B15+B6	10*SIN(B4*B16)
17		B16+B6	10*SIN(B4*B17)
18		B17+B6	10*SIN(B4*B18)
19		B18+B6	10*SIN(B4*B19)
20		B19+B6	10*SIN(B4*B20)
21		B20+B6	10*SIN(B4*B21)
22		B21+B6	10*SIN(B4*B22)
23		B22+B6	10*SIN(B4*B23)
24		B23+B6	10*SIN(B4*B24)
25		B24+B6	10*SIN(B4*B25)

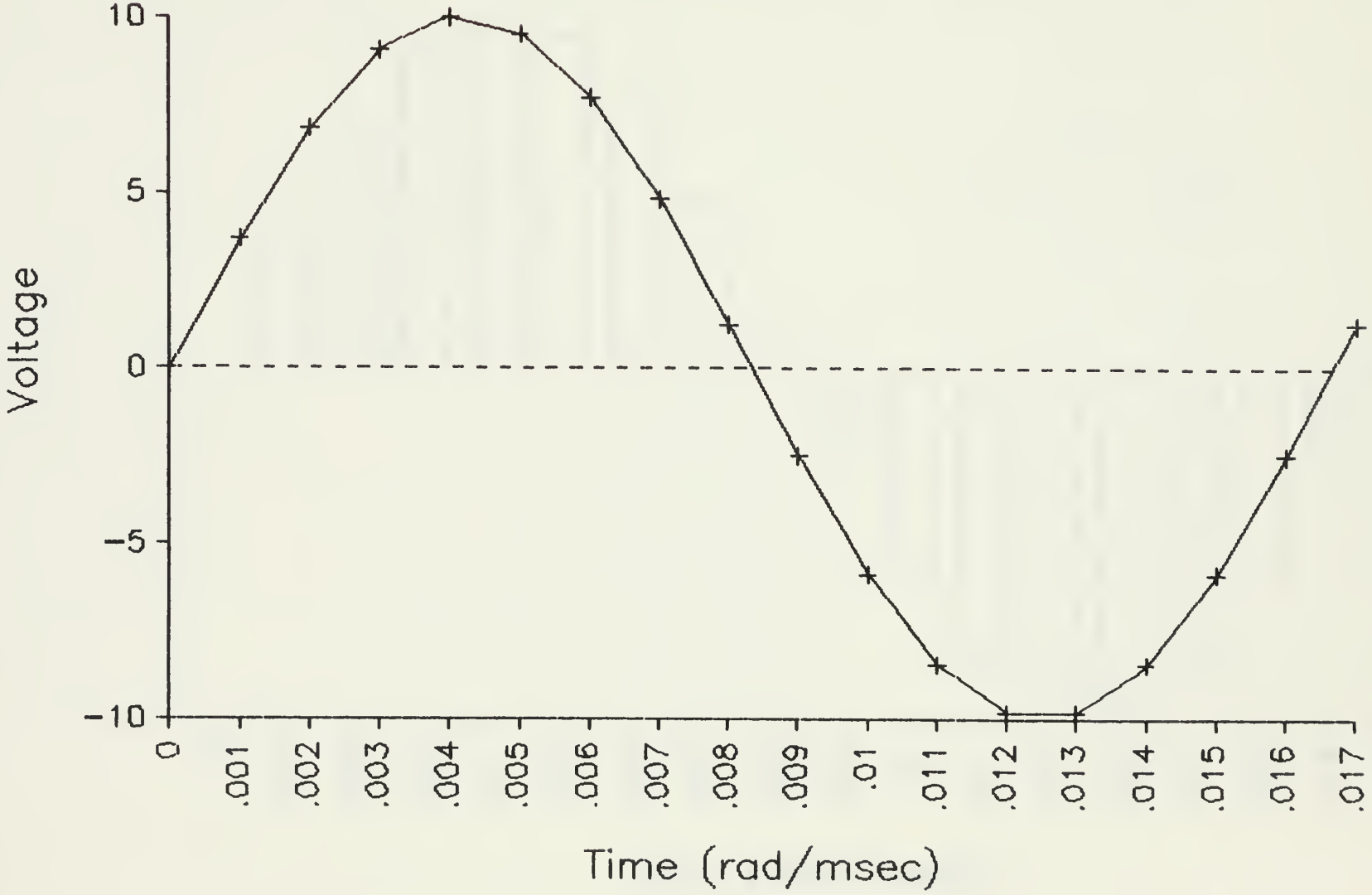
Figure 1

	A	B	C
1	Sine Wave		
2	---	---	---
3	zero deg coef	10	
4	frequency (r/s)	377	
5	1st value of t	0	
6	time increment	.001	
7	---	---	---
8	Voltage	0	0
9	Time (rad/msec)	.001	3.681328105444
10	60Hz Sine Wave	.002	6.845600545913
11	Figure 6	.003	9.048383969096
12		.004	9.980289585118
13		.005	9.510427925783
14		.006	7.704792737300
15		.007	4.816991923216
16		.008	1.252627409648
17		.009	-2.48767309216
18		.01	-5.87857103378
19		.011	-8.44380270283
20		.012	-9.82307216031
21		.013	-9.82265609060
22		.014	-8.44261293216
23		.015	-5.87677466970
24		.016	-2.48552244040
25		.017	1.254830282369

Figure 2

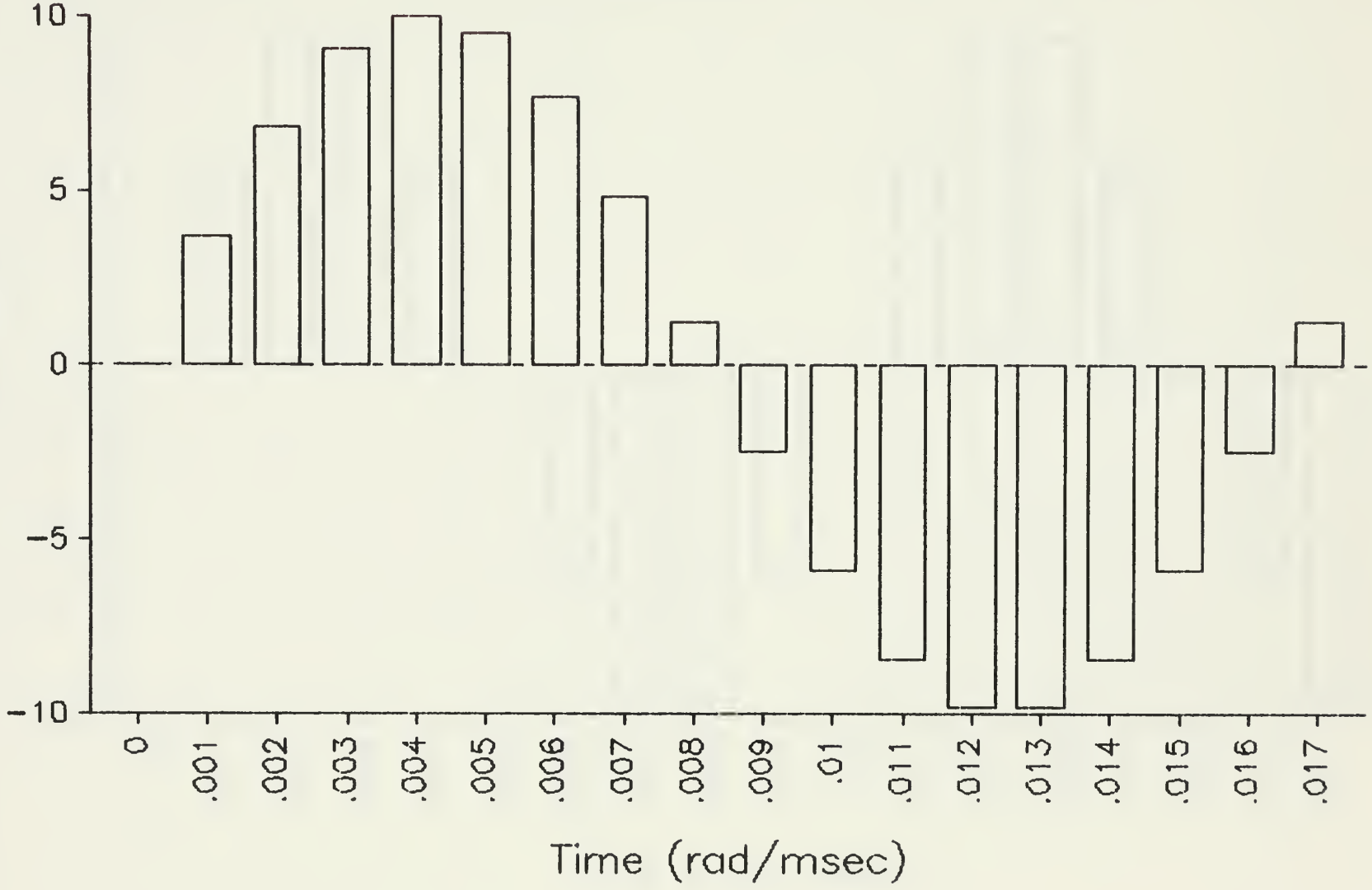
60Hz Sine Wave

Figure 3



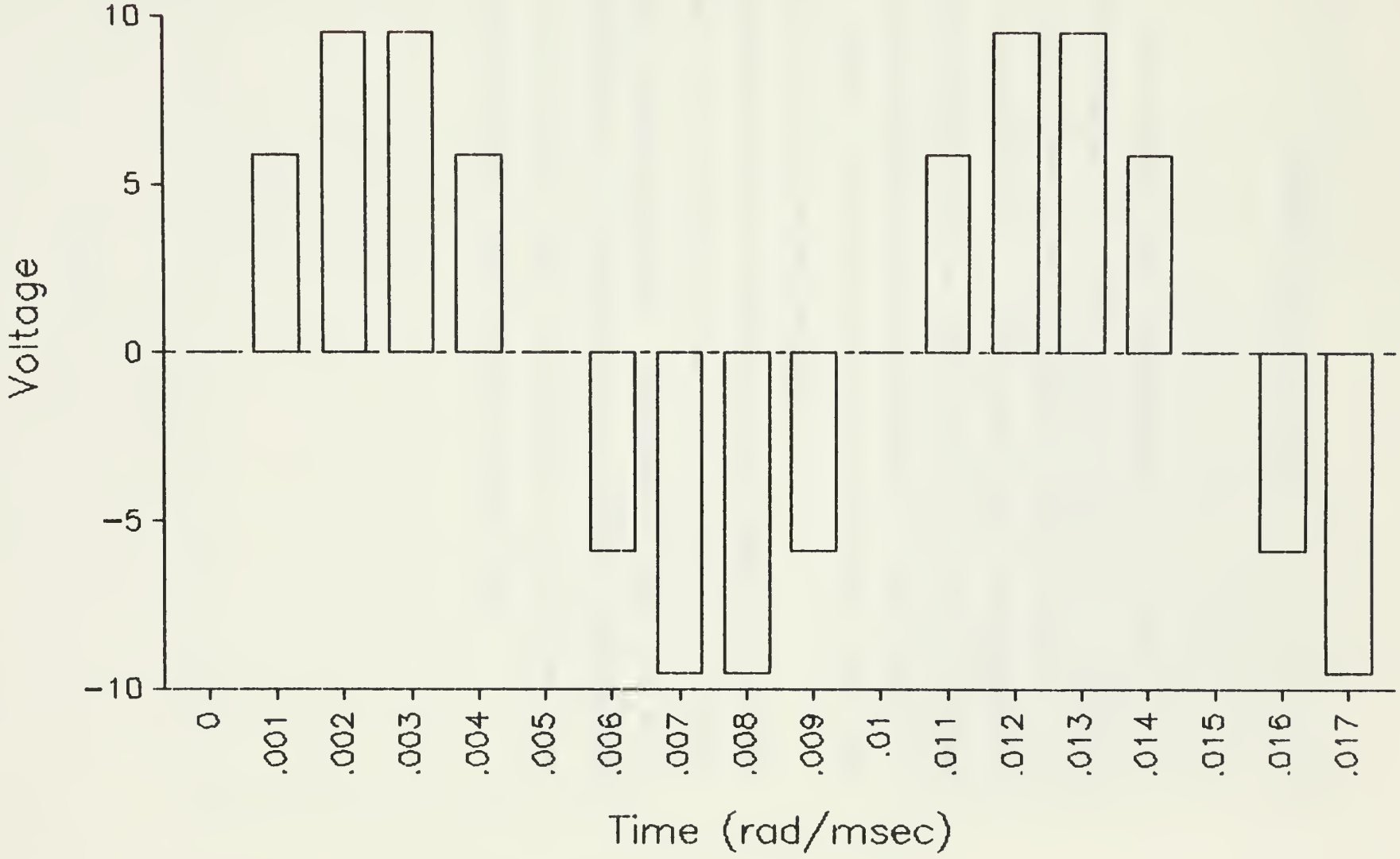
60Hz Sine Wave

Figure 4



100Hz Sine Wave

Figure 5



Digital Logic Analysis

The following pages demonstrate the use of a spreadsheet program in solving Boolean equations. Figure 1 represents the instructions to analyze the equation $(A \cdot \bar{B}) + (C \cdot \bar{D})$. Figure 2 is the truth table that was generated by the spreadsheet program. Figure 3 is a listing of the program that modified the above equation to read $(A \cdot \bar{B}) \cdot (C \cdot \bar{D})$. Figure 4 is the resultant truth table that was generated by the customized program.

These basic equations demonstrate the capability of the spreadsheet to be utilized in the field of digital circuits and digital circuit analysis. These models could be used for demonstration or practical application. Repetitive usage and modification would be possible with minimum time spent re-analyzing the equations and circuit logic.

	A	B	C	D	E	F
	Digital Logic	A	B	C	D	Logic Expression Output
1	1 True	1	1	1	1	OR(AND(B3,NOT(C3)),AND(D3,NOT(E3)))
2	0 False	1	1	1	0	OR(AND(B4,NOT(C4)),AND(D4,NOT(E4)))
3		1	1	0	1	OR(AND(B5,NOT(C5)),AND(D5,NOT(E5)))
4		1	1	0	0	OR(AND(B6,NOT(C6)),AND(D6,NOT(E6)))
5		1	0	1	1	OR(AND(B7,NOT(C7)),AND(D7,NOT(E7)))
6		1	0	1	0	OR(AND(B8,NOT(C8)),AND(D8,NOT(E8)))
7		1	0	0	1	OR(AND(B9,NOT(C9)),AND(D9,NOT(E9)))
8		1	0	0	0	OR(AND(B10,NOT(C10)),AND(D10,NOT(E10
9		0	1	1	1	OR(AND(B11,NOT(C11)),AND(D11,NOT(E11
10		0	1	1	0	OR(AND(B12,NOT(C12)),AND(D12,NOT(E12
11		0	1	0	1	OR(AND(B13,NOT(C13)),AND(D13,NOT(E13
12		0	1	0	0	OR(AND(B14,NOT(C14)),AND(D14,NOT(E14
13		0	0	1	1	OR(AND(B15,NOT(C15)),AND(D15,NOT(E15
14		0	0	1	0	OR(AND(B16,NOT(C16)),AND(D16,NOT(E16
15		0	0	0	1	OR(AND(B17,NOT(C17)),AND(D17,NOT(E17
16		0	0	0	0	OR(AND(B18,NOT(C18)),AND(D18,NOT(E18

Figure 1

	A	B	C	D	E	F
	Digital Logic	A	B	C	D	Logic Expression Output
1	1 True	1	1	1	1	0
2	0 False	1	1	1	0	1
3		1	1	0	1	0
4		1	1	0	0	0
5		1	0	1	1	1
6		1	0	1	0	1
7		1	0	0	1	1
8		1	0	0	0	1
9		0	1	1	1	0
10		0	1	1	0	1
11		0	1	0	1	0
12		0	1	0	0	0
13		0	0	1	1	0
14		0	0	1	0	1
15		0	0	0	1	0
16		0	0	0	0	0

Figure 2

	A	B	C	D	E	F
	Digital Logic	A	B	C	D	Logic Expression Output
1	1 True	1	1	1	1	AND(AND(B3,NOT(C3)),AND(D3,NOT(E3)))
2	0 False	1	1	1	0	AND(AND(B4,NOT(C4)),AND(D4,NOT(E4)))
3		1	1	0	1	AND(AND(B5,NOT(C5)),AND(D5,NOT(E5)))
4		1	1	0	0	AND(AND(B6,NOT(C6)),AND(D6,NOT(E6)))
5		1	0	1	1	AND(AND(B7,NOT(C7)),AND(D7,NOT(E7)))
6		1	0	1	0	AND(AND(B8,NOT(C8)),AND(D8,NOT(E8)))
7		1	0	0	1	AND(AND(B9,NOT(C9)),AND(D9,NOT(E9)))
8		1	0	0	0	AND(AND(B10,NOT(C10)),AND(D10,NOT(E10))
9		0	1	1	1	AND(AND(B11,NOT(C11)),AND(D11,NOT(E11))
10		0	1	1	0	AND(AND(B12,NOT(C12)),AND(D12,NOT(E12))
11		0	1	0	1	AND(AND(B13,NOT(C13)),AND(D13,NOT(E13))
12		0	1	0	0	AND(AND(B14,NOT(C14)),AND(D14,NOT(E14))
13		0	0	1	1	AND(AND(B15,NOT(C15)),AND(D15,NOT(E15))
14		0	0	1	0	AND(AND(B16,NOT(C16)),AND(D16,NOT(E16))
15		0	0	0	1	AND(AND(B17,NOT(C17)),AND(D17,NOT(E17))
16		0	0	0	0	AND(AND(B18,NOT(C18)),AND(D18,NOT(E18))

Figure 3

	A	B	C	D	E	F
	Digital Logic	A	B	C	D	Logic Expression Output
1	1 True	1	1	1	1	0
2	0 False	1	1	1	0	0
3		1	1	0	1	0
4		1	1	0	0	0
5		1	0	1	1	0
6		1	0	1	0	1
7		1	0	0	1	0
8		1	0	0	0	0
9		0	1	1	1	0
10		0	1	1	0	0
11		0	1	0	1	0
12		0	1	0	0	0
13		0	0	1	1	0
14		0	0	1	0	0
15		0	0	0	1	0
16		0	0	0	0	0

Figure 4

Chapter 5

Conclusion

Microcomputers are an asset to the electrical engineer. They allow him access to significant computing power with relatively small capital expenditure. Because of the proliferation of these small computers and their associated software, more companies and individual engineers can afford to invest in a computer system. The microcomputer can be used as a "stand-alone" or as an interface to a mainframe computer. Either way, this increased access to a computer system assists the electrical engineer in applying his analytical capabilities to develop solutions to complex problems.

The electrical engineer cannot compete with the man-years of effort that software manufacturers are expending in the development of general application software. It is up to the engineer to adapt wordprocessing, and spreadsheet programs to meet his daily computer needs. Engineering software programs, that are application specific, should be utilized whenever possible; however, it is rather obvious that the cost of development of these programs will limit availability to all but a few.

Educational institutions have a responsibility to

instruct the engineering student in the use and application of "software programs" and microcomputers. If courses are developed early in the college students educational curriculum, microcomputers could be used throughout the educational process to benefit both the student and the institution. Perhaps more importantly, the engineering student will have experienced the use of these microcomputers in the formal learning process which will enhance its use throughout his career. For this evolution to occur, the universities must have access to low cost software and microcomputer components that can be immediately utilized in the classroom and laboratories. If manufacturers are to be expected to continue to provide their products at significant educational discounts it is reasonable and understandable that these same firms will expect that copyright laws be obeyed. All parties; educators, students, and software manufacturers, must find workable solutions to allow the educational process to continue as efficiently as possible. This paper has presented several applications of general application software programs that can be used to assist the electrical engineer in his daily efforts. Whether the engineer is connected with a large firm or a one-man company, the microcomputer and its associated software can enhance design efforts. The microcomputer and its associated software can also be used in the educational environment to assist in the

teaching of electrical engineering theory and problem solution. It is believed that software manufacturers will continue to develop software programs that meet the needs of the largest group of users. To do this, microcomputer programs will continue to have a large degree of flexibility and application. The programs will be developed for simple operation yet with advanced functions so that solutions to complex problems can be developed. As such, it is up to the engineer and the educational environment to utilize these programs in the field of electrical engineering.

It is important to mention that future generations of software will integrate the functions of wordprocessing, spreadsheet, graphics, and an electronic file system called database. Companies like Innovative Software, located in Overland Park, Kansas, are due to release this next generation of microcomputer software in the next few months. Discussion with this company indicate that they too are willing to offer substantial discounts to educational institutions to allow use of their software products in the classroom. The significant point here is that as microcomputer hardware and software become more sophisticated, the value of these products to the educational process and the individual engineer can only increase. Understandably, it should be the goal of both the individual electrical engineer and the electrical engineering department to effectively apply these automation

tools as best they can.

Chapter 6

Future Work

Development of microcomputer software has become a major industry in the United States. Without the desired software, it is common knowledge that the computer is just another useless "machine." Because of the affordability and wide application of the microcomputer, companies are expending many man-years of effort to produce the "best" general application software programs. Today the emphasis is on "integrated" packages of the three most popular modules of software: word processing, spreadsheet, and database.

These integrated packages are capable of complete interface with one-another in the transfering of information. This means that when data is developed in a file and is later needed for a report, that specific information can be transferred to the word processing program. The same is true of spreadsheet data. In fact, if word processing contained a table of information that had been typed for an earlier requirement, this information could now be transferred to either spreadsheet or database files. Included in these integrated packages of software programs is a graphics program. This provides the

capability to generate graphs and enter them into word processing along with the applicable tables of data. With multi-screen capabilities, the integrated program's user is allowed to develop a report by combining information on screen before it ever goes to "hardcopy." This allows the "layout" of text, data, spreadsheet and graphics, all in customized format, before the text is ever printed.

From the examples given in this report it is quite clear that many more applications of spreadsheet are possible. Solutions to mathematics, circuit analysis, and more complex analysis of digital circuits and their truth tables are possible. With database software, the capability exists to develop wire lists for circuits. Also, pertinent data could be stored on the most commonly used integrated circuits. Later, this same information could be recalled with the capability of generating the information in a variety of formats. Also, with integrated graphics, the capability exits to develop custom designs of these programs to give almost "instantaneous" results for a specific application.

If the electrical engineer is to limit the time spent programming microcomputers and utilize available software, future applications of integrated software packages must be developed. These applications are limited only by an individuals imagination and knowledge of the system being modeled.

BIBLIOGRAPHY

Primary Sources

Works Cited

Archer, R., "The IBM PC XT and DOS 2.0", Byte Magazine, November 1983, p. 294

Christiansen C. & Gens F., "Could 1,000,000 IBM-PC Users Be Wrong?", Byte Magazine, November 1983, pp. 135-138

Curran, L. J. & Shuford, R. S., "IBM's Estridge", Byte Magazine, November 1983, p. 88

Curtin, Dennis P., "Introduction", Wordstar Handbook, New York, Van Nostrand Reinhold Publishing 1983, p. vii

Lehrman, Stevanne R., "Peachtext 5000", Byte Magazine, April 1984, pp. 186-202.

Taylor, Bonita E., ed., PC THE BUYERS GUIDE, New York: Ziff-Davis Publishing, p. 12

"Computers:, Consumer Reports, October 1983, p. 469

"The Computer as Super-Typewriter", Consumer Reports, October 1983, p. 540

"Welcome, IBM, to Personal Computing", Byte Magazine, November 1983, p. 137

"What Home Computers Can Do", Consumer Reports, September 1983, p. 464

Collected Documents

The Ratings Book, Wynnewood, PA: Software Digest, 1984/1985 Edition

Lewis, T.G., Using The IBM Personal Computer, Reston, Va: Prentice-Hall, 1983

Puotinen, C.J., Using the IBM Personal Computer: Wordstar, New York: Holt, Rinehart and Winston, 1983

Wood, C., The SuperCalc Program Made Easy, Berkeley: Osborne/McGraw-Hill, 1984

Appendixes

Appendix A

Copying Computer Software, A Legal Opinion

The following article appeared in the Personal Computing magazine in November, 1983 under the title; "Copying Computer Software For Educational Purposes: Is it Allowed?". Trudy Bell is a New York-based journalist who wrote the article with legal opinions addressed by Daniel T. Brooks of Computer Law Advisors in Springfield, Va. Mr. Brooks holds degrees in law and electrical engineering from Princeton and Stanford Universities. He is secretary of the Computer Law Association as well as a member of the American Bar Association.

Because the article is a legal opinion and so relative to this research paper, it (the article) is reproduced in whole with acknowledgement to Trudy Bell and Daniel T. Brooks for its contents. "Reprinted with permission from Personal Computing, November 1983, pg. 236-242, Copyright 1983, Hayden Publishing Company."

"Take not from others to such an extent and in such a manner that you would be resentful if they so took from you."

Joseph McDonald
"Noninfringing Uses"
Bulletin of the Copyright
Society, 9:466-467, 1962

The educational software business is booming. In an effort to bring computer literacy to students at all levels of the educational system, educators and school systems are wrestling with the overwhelming investment in hardware and software that is required. Producing copies of computer programs is so essential to their use, so inexpensive and untroubling to effect, and so much in furtherance of the noble educational purpose, that educators are inexorably led to ask: "Is it as legitimate to make multiple copies of programs, one for each student in a course, as it is to make multiple copies of reading materials?"

They answer their own question "yes," and for authority they point to Section 107 of the 1976 Copyright Act, which states in part that "use of a copyrighted work...for purposes such as...teaching (including multiple copies for classroom use)..., is not an infringement of copyright." On their face, those words seem pretty encouraging. But they require substantial interpretation and knowledge of copyright basics.

A bit of background

Copyright is federal protection of intellectual property. According to the 1976 Copyright Act, works written after January 1, 1978 are automatically protected by copyright. Registration of that copyright with the Copyright Office of the Library of Congress is an elective procedure.

Congress specifically intended the 1976 Copyright Act to cover computer programs as a subcategory of literary works, and, most computer software is protected by copyright.

The copyright owner, who is generally the author of the software program, has five exclusive rights: He is the sole owner of the rights to reproduce his own work in copies, prepare derivative works based on the original, perform the work publicly, display the work publicly, and distribute the work to the public. Those rights are divisible--that is, the owner can split them up and assign them to others as he desires.

The rights an ordinary user gets for his money

depend on whether he acquired his particular copy of the program through sale or through lease. In the case of personal computer software, that distinction is not always obvious.

If the disk of the program was sold to you so that you own it (as you own the copy of a book you buy), then under Section 117 of the 1976 Copyright Act you have the statutory right to make as many copies of the programs as you need in order to use it or to store it for backup or archival purposes. You don't have the right to make and distribute extra copies of the original program to someone else.

You may, however, have leased the disk for a one-time fee. How can you tell? If the disk of the program is leased, the license that comes with the disk (sometimes visible through the shrink-wrap) should make that distinction clear. The license accompanying a leased copy is a contract that spells out your rights. Usually the license terms for a leased disk are more restrictive than the ones governing owned copies under copyright law. The basic principle with licenses is that unless the license says you may do something, you may not do it. Unless the license gives you explicit permission, you may not copy the program. You certainly can't make copies and distribute them. There is, however, a concept of "fair use" in the Copyright Act covering how much use you may make of someone else's literary material for your own purposes. And fair use is the crux of the issue in the educational setting.

Fair use in schools

Fair use is often defined as the privilege in others besides the copyright owner. The fair use doctrine was created to encourage creativity, and to introduce flexibility and equity into the copyright law, to balance the educational needs of the general public against the exclusive rights of the copyright owner. (We should make it clear here that we are talking about copyright only. Some computer programs are made available under trade secret licenses. That's not the usual case, but it's not an uncommon case. There is, however, no fair use concept in state trade secret law.)

Although Section 107 of the Copyright Law states that it is permissible for teachers to make multiple copies of copyrighted works for classroom use, the section goes on to specify guidelines for determining just how much copying is fair. "...Factors to be considered shall include--(1) the purpose and character of the use, including whether such use is of commercial nature or is for nonprofit educational

purposes; (2) the nature of the copyrighted work; (3) the amount of substantiality of the portion used in relation to the copyrighted work as a whole; and (4) the effect of the use upon the potential market for or the value of the copyrighted work."

In considering copying software for classroom use, in many cases the first and second criteria pose few problems. It is with the third criterion regarding "the amount and substantiality of the portion used" that the problems begin.

With few exceptions, a computer program is relatively useless unless all of it is copied--or so substantially all of it that we might as well talk about all of it. That makes a computer program very different from a book, wherein a single chapter can be useful as a reading in a course. So in the case of computer programs, the criterion "the amount and substantiality of the portion used in relation to the copyrighted work as a whole" is a serious factor: We're considering copying the whole work--which is outside the bounds of any concept of fair use.

Furthermore, the noble aims of scholarship do not provide educators with any privileged exception to this law. In devising the Copyright Law, Congress deliberated long and hard about what was involved. The judiciary committee of the House of Representatives stated that "specific exemptions for certain reproductions of copyrighted works for educational and scholarly purposes from copyright control is not justified." The committee went on to approve guidelines that stated "multiple copies (not to exceed in any event more than one copy per pupil in a course) may be made by or for the teacher giving the course for classroom use or discussion; provided that: A. the copying meets the tests for brevity and spontaneity...; and, B. meets the cumulative effect test...; and, C. that each copy includes a notice of copyright." The test for brevity specified the number of words permitted for a photocopied excerpt, always fewer than 2500 words for a computer article or fewer than 1000 words or 10 percent of a longer work, whichever is less. The test for spontaneity means that "the copying is at the instance and inspiration of the individual teacher" and is not an institutional technique of the school. The test for cumulative effect means that "the copying of the material is for only one course in the school in which the copies are made," and that not too many copies are made from one collection. And as if all this weren't clear enough, the committee declared a supervening prohibition: "Copying shall not substitute for the purchase of books, publisher's reprints or periodicals, be directed by high authority, or be

repeated with respect to the same item by the same teacher from term to term."

Although all these guidelines were specified for printed materials, their drift is clear: Copying entire works is by far the exception and not the rule, and then only for very short specific works--and never on an institutional scale.

The fourth criterion in determining fair use, regarding the effect of the use upon the potential market for the work, is also a trouble spot for computer programs. If many classrooms across the country proliferate copies of a program for their students, obviously we could be talking about material numbers of copies--into the thousands. That is not insubstantial impact on the market. Furthermore, in the case Marcus v. Rowley in 1983, in which a home economics teacher was prosecuted for distributing a mere 15 copies of a recipe booklet containing material plagiarized from another home economics teacher, the court ruled that although the copying of a copyrighted work on the potential market is often seen as the most important criterion of fair use, it must be judged in light of the other three criteria. "The mere absence of measurable pecuniary damage does not require a finding of fair use,...This conclusion is in harmony with the congressional guidelines...with respect to fair use in an educational context."

In short, even in the cause of education, one cannot even brook a case for straight disk-to-disk duplication of an entire computer program and have it considered fair use. Excerpting only small portions of a program is within the intentions of the fair use doctrine. For example, if you copy an insubstantial portion to illustrate a point (say, in programming), or if you exhibit a portion publicly (say, to display to students what object code resulted from a particular source code statement), or if you are preparing adaptations (say, to make the displays look different), you will probably have no difficulty in the classroom even though you are doing all this without the express authority of the copyright owner. All these uses are probably fair use. In all cases, the "amount and substantiality" of the copying is the crucial test. Wholesale copying of an entire work is outside any concept of fair use.

The liability of libraries

This picture may not be so grim for educators' budgets as it first appears. Although copyright law prohibits anyone--including educators--from proliferating multiple copies of copyrighted works such as computer programs, the statue is quite clear that the owner of a

copy can do anything else he wishes with that copy--including lending it like a book. Running a library of software may reduce the overall number of copies a school may need to purchase, if each copy of the program can be used serially by a number of students.

A natural question arises here about the legal responsibility a library may have for borrowers who may make unauthorized copies of the programs. There is a growing trend in the personal computing world for rental libraries to spring up to rent programs for a modest fee to people who wish to try them out before deciding on a final purchase. Micropro and several other vendors are suing these rental institutions for allegedly aiding and abetting copyright infringement, contending that the renters are most likely to take the disks home only to make illegitimate copies for themselves. That, of course, is a question of fact. It is likely, however, that the vendors are going to lose their suit under copyright law, which is quite clear that the owner of a copy can dispose of it as he wishes.

A school library is in an even more defensible posture than the rental libraries, in that it does not charge students for the programs it may lend for educational purposes. Furthermore, the fact issue rests on whether or not illegal copying is truly the primary reason people might borrow software from a library. In an educational setting, that probably is not the case.

Even if there should be an occasional infringement, the library--by virtue of honorable intentions and practices--is afforded some legal protection against a suit. It is likely, for example, that the library is not going to lend an original disk, but a working copy made from an original stored as a backup. (Note: in such a case there must be one original disk stored for each disk loan.) If the library lends the working disks having no reason to suspect that the borrowers will abuse the privilege, then the library is protected against statutory damages for copyright infringement by Section 504 (c) of the Copyright Act. Section 504 (c) provides that the court shall remit (that is, not assess) statutory damages in the case of "an employee or agent of a nonprofit educational institution, library, or archive acting within the scope of his or her employment who...infringed by reproducing the work in copies." However, if the library has any reason to know that unauthorized copying is rampant, then the library's preparation of the working copies is as much a copyright infringement as the borrowers'--because it furthers the borrowers' infringement.

An additional practical note: To ease the financial burden of buying the necessary software, the library or the school itself could negotiate a bulk purchase for multiple copies at substantial discount. There is ample precedent; bulk purchases are commonly negotiated for other school supplies such as textbooks. But software vendors might be particularly receptive for other reasons. First, piracy is so rampant that if an educator were honest enough to make a pitch, the vendor will probably want to encourage more such activity. Second, the more students get used to using a particular program, the more they may be inclined to buy it when they go to work for someone--so the vendor has the opportunity to capture a large number of potential purchasers at their entry into the system. Last, if appropriate tax consequences can be arranged, in some cases a vendor might even be induced to donate the copies to the school.

The network connection

The copying of educational software in a computer-aided instruction network is a multifaceted legal question. Section 117 of the Copyright Act, which was introduced in 1980 specifically to cover computer programs, states in part that "it is not an infringement for the owner of a copy of a computer program to make or authorize the making of another copy...of that computer program provided: (1) that such a new copy...is created as an essential step in the utilization of the computer program in conjunction with a machine, and that it is used in no other manner, or (2) that such new copy...is for archival purposes only and that all archival copies are destroyed in the event that continued possession of the program should cease to be rightful. Any exact copies prepared in accordance with the provisions of this section may be leased, sold, or otherwise transferred, along with the copy from which such copies were prepared, only as part of the lease, sale, or other transfer of all rights in the program."

The crux of the network question is whether the copying is "an essential step for the utilization of the program in conjunction with a machine." Certain educational software--for example, a program that is designed to take a number of personal computers linked in a network and make them usable as an instructional tool under the remote control of a teacher--may reproduce portions of itself in the memory of each of the computers in the network. That copying is legitimate: The program was designed to perform that copying function. The fact that there is a copy then resident in each of the personal computers in the network is not a problem. That copying is essential in

the use of the program.

However, duplicating the master disk of the program and putting it into 10 other classrooms for their networks is not permissible under Section 117: Again, that act is proliferating multiple copies of a copyrighted work.

It is also not permissible to take a program that was not designed to copy itself in a network, and to distribute it to the various personal computers in the network. For example, downloading WordStar or VisiCalc from a master disk into other personal computers connected in a network for many simultaneous users is not legitimate, because that proliferation is not designed into the program--even if the use of the program is entirely internal to each computer and the code never sees the surface of a magnetic disk.

This consideration highlights an unresolved legal question in Section 117 as to whether the statute, the teacher, and the vendor all mean the same thing when they consider a "machine." In the above example of a networking program, the program itself defines the machine as all the components of the network. But that definition isn't valid for, say, VisiCalc, which was designed to be used in a stand-alone microprocessor not even in a multiuser environment. From the teacher's perspective, one copy of VisiCalc in a multiuser environment is use of a single copy on a single network, despite the fact that each of the intelligent parts of machine (the personal computers) has its own local copy. From VisiCorp's perspective, every copy but the master is unauthorized, because putting the program on the network results in a proliferation of copies and users that cut into sales. In view of the fairly substantial impact on VisiCorp's sales that unrestricted copying in networks would have, the courts would be likely to decide in favor of VisiCorp in this example. (A not of caution to vendors: If VisiCorp were to hint in its promotions or other literature that a program is designed for a multiuser environment, the court's finding could reverse.)

Rule of thumb

If you are proliferating the number of users of a software program, and the program was not designed to be used by multiple persons simultaneously, you are undoubtedly violating copyright law. It is outside any concept of fair use to allow wholesale copying of entire copyrighted works such as software programs--even for classroom use. However, any number of people may use the same copy of a program serially--for example, by borrowing it from the school library.

As can be seen from the previous report, the copyright law as applied to the educational institution can be somewhat difficult to interpret. The term "fair use" and "proliferation" gives the teacher a reasonable idea of what is legal and illegal. The next several pages show an example of the letter that was sent for this research project and the response that was received from Sorcim Corporation and MicroPro International Corporation. These responses provide information on the type of licensing agreements that are required by software companies before their material may be used by the educational institution. Careful attention should be taken when reviewing these exhibits. It should be noted that both the teacher and individual students, who are participating in a particular class, recognize that they are using copyrighted material. The only way to overcome this requirement would be to purchase a number of original disks, greater than the number of students expected in a particular class, and "check out" the program from a "software library". This does not release the teacher from ensuring that the students understand the proper use of copyrighted material but it does reduce the amount of bureaucracy involved in trying to operate the educational classroom process as efficiently as possible. This may have some effect on the price that could be negotiated with a software company on a particular

program. Discussions with the particular company would be the only way to verify quantity discounts. Both Sorcim and MicroPro offer "significant" discounts for educational institutions that are willing to follow their guidelines in the use of software. For information purposes the price list has been included for the different products offered by these two companies.

THE UNIVERSITY OF KANSAS

Electrical and Computer Engineering
Learned Hall
Lawrence, Kansas 66045-2228
(913) 864-4620

President
SORCIM Corporation
2310 Lundy Avenue
San Jose, California 95131

April 4, 1984

Dear Sir:

Let me introduce myself; my name is Jim Hague and I am a Lieutenant in the Civil Engineer Corps of the United States Navy. At present I am on a leave of absence for one year while I earn my Master's Degree in electrical engineering. I am studying digital design with an emphasis towards computer design.

As part of my research project and for my future use of microcomputers in the Navy, I would like to evaluate computer software for its adaptability to the field of electrical engineering. Software such as **SuperWriter and SuperCalc** would be evaluated as a package for its adaptation to engineering format and problem solutions.

I ask that your company consider my request and provide the University of Kansas with a copy of this software so that it could be included in this evaluation. Dealer demonstration copies, with their built-in program limitations, would not be suitable for this evaluation. The University would like to use this software after my initial evaluation for further evaluation by other students. These future evaluations would determine the applicability of requiring students to use certain software and microcomputers in required courses. If necessary, all donated software would be returned at the end of my evaluation with the assurance that all copies had been erased.

For the purpose of performing this evaluation, I have purchased an IBM PC computer with dual disk drives, color monitor, graphics, coprocessor, and 256K RAM of memory. The operating system is DOS 2.1. Any software provided must be compatable with this system.

I would request that your reply be sent to the Department of Engineering, Attention: Professor Dale Rummer.

The Department of Engineering and myself take this opportunity to thank you for your favorable consideration and look forward to your positive response.

Sincerely,

Dr. Dale Rummer
Professor

James R. Hague
Graduate Student

February 24, 1984

Mr. Dale Rummer
University of Kansas
Department of Engineering
Learned Hall
Lawrence, Kansas 66045-2228

Dear Mr. Rummer:

Thank you for your interest in training users on Sorcim products.

In order to serve your training needs, we have developed the Sorcim Educational Support Program. This program offers you minimal cost on course materials, full technical phone support and referral of prospective students by our staff. We intend to extend the program to include special media training aids, course curriculum and a complete Sorcim Educational Support Program Catalog, which will include names of all training and educational organizations recommended by Sorcim.

Enclosed you will find:

1) A summary of the Sorcim Educational Support Program

2) A Sorcim Educational Support Program Training Materials Price List

3) A Sorcim Product List

4) The Sorcim Educational Support Program Agreement Form which must be completed and signed (and returned) in order to participate in the Program

5) A sample Student Registration Card

If you are interested in participating in the Sorcim Educational Support Program, please complete and return the Agreement Form.

We look forward to your participation in the program.

Sincerely,

Renee D. Amaya

Renee D. Amaya
Training Administrator

2310 Lundy Avenue ■ San Jose, CA 95131 Telephone (408) 942-1727 Telex 910 338 2003

SORCIM EDUCATIONAL SUPPORT PROGRAM
PROGRAM SUMMARY
DECEMBER 29, 1983

We, at Sorcim, recognize the importance of educational support for users and appreciate your role in the educational process. In order to assist you in your efforts to make training available on Sorcim products, we have developed the Sorcim Educational Support Program. Following is a description of aids and services as well a future developments available through Sorcim.

MINIMAL COST ON COURSE MATERIALS

You may obtain Sorcim products and support materials, such tutorials, for minimal cost. Please see enclosed price list for details.

FREE TECHNICAL SUPPORT

Students or instructors are welcome to call our main office for aid in using our products. Please call 408-942-1727 and ask for Technical Support.

HARD DISK LICENSE AGREEMENT

In order to access Sorcim products on hard disk from multiple machines, you need to purchase a license agreement. Please call to inquire.

REFERAL OF PROSPECTIVE STUDENTS

Any inquiries reguarding training on our products from prospective students in your area will be given your name as a recommended training institution.

FUTURE - COMPLETE COURSE CURRICULUM

We are in the process of developing curriculum on all Sorcim products. This curriculum will include a complete set of materials needed to present a course on Sorcim products: Instructor's Guide, Student Workbook and Overheads. Available: first quarter, 1984. Cost: to be determined. Kit materials also available separately.

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FUTURE - SPECIAL MEDIA TRAINING AIDS

Video Tape - "Guide to Electronic Spreadsheets". Approximately 10 minutes, this tape is a good overview of use of the computer and features of a spreadsheet. Ideal as an introduction to your Supercalc courses. Available: first quarter, 1984. Cost: to be determined.

Sorcim Product Demos. These demos will give concise product overviews and show the products "in action". The product demos could serve as an introduction to your courses as they demonstrate the actual functioning of the program. Available: first quarter, 1984. Cost: to be determined.

Laser Disk Tutorial. This fully interactive laser disk system provides the ideal self-paced training environment. The student may select the topic to cover, paced at a comfortable rate. Subject matter branches based on user response. Ideal tool to offer for "off-hours" learning. Available: second quarter 1984. Cost: to be determined.

FUTURE - SORCIM EDUCATIONAL SUPPORT CATALOG

The Sorcim Educational Support Catalog will include the name, address and description of all recommended educational institutions teaching courses on Sorcim products. Distribution will include all registered Sorcim users, Sorcim dealers, distributors and Reps. The catalog will also be sent in selected mass mailings. The Sorcim Educational Support Catalog promises to be excellent advertising for your courses. Available: second quarter, 1984. Cost: none.

Product Availability List

SuperCalc

List Price $195.00

Part #	Description	Hardware/Format	Disk Size	Operating System	CPU	Version
11-121-52	SuperCalc	A.B. Dick	5¼	CPM 2.X	8085	1.12
11-131-15	SuperCalc	Apple II	5¼	CPM 2.X	Z80	1.12
11-131-42	SuperCalc	Beehive Topper	5¼	CPM 2.X	Z80	1.12
11-131-04	SuperCalc	Control Data 110	5¼	CPM 2.X	Z80	1.12
11-144-55	SuperCalc	DEC Rainbow	5¼	CPM 86	8086	1.12
11-131-27	SuperCalc	HP 86/87	5¼	CPM 2.X	Z80	1.12
11-146-03	SuperCalc	IBM PC	5¼	IBM DOS	8088	1.12
11-144-05	SuperCalc	IBM PC CPM 86	5¼	CPM 86	8088	1.12
11-121-01	SuperCalc	IBM 3740	8	CPM 2.X	8080	1.12
11-144-01	SuperCalc	IBM 3740	8	CPM 86	8086	1.12
11-131-47	SuperCalc	Kaypro II	5¼	CPM 2.X	Z80	1.12
11-131-24	SuperCalc	MAI-Basic Four	5¼	CPM 2.X	Z80	1.12
11-131-20	SuperCalc	Northstar	5¼	CPM 2.X	Z80	1.12
11-131-31	SuperCalc	Uniterm (OKI)	5¼	CPM 2.X	Z80	1.12
11-131-48	SuperCalc	Otrona/Attache	5¼	CPM 2.X	Z80	1.12
11-131-22	SuperCalc	Superbrain	5¼	CPM 2.X	Z80	1.12
11-121-56	SuperCalc	TAB	8	CPM 2.X	Z80	1.12
11-144-56	SuperCalc	TAB	8	CPM 86	8088	1.12
11-146-51	SuperCalc	TI-Professional	5¼	MS DOS	8088	1.12
11-131-26	SuperCalc	TVI 800 SER./Televideo	5¼	CPM 2.X	Z80	1.12
11-131-23	SuperCalc	Vector Graphics	5¼	CPM 2.X	Z80	1.12
11-144-40	SuperCalc	Victor 9000	5¼	CPM 86	8088	1.12*
11-146-40	SuperCalc	Victor 9000	5¼	MS DOS	8088	1.12*
11-131-25	SuperCalc	WangWriter	5¼	CPM 2.X	Z80	1.12
11-131-10	SuperCalc	Xerox 820-I/Xerox-I	8	CPM 2.X	Z80	1.12
11-131-11	SuperCalc	Xerox 820-I/Xerox-I	5¼	CPM 2.X	Z80	1.12
11-131-12	SuperCalc	Xerox 820-II/Xerox-II	8	CPM 2.X	Z80	1.12
11-131-13	SuperCalc	Xerox 820-II/Xerox-II	5¼	CPM 2.X	Z80	1.12
11-131-41	SuperCalc	Zenith Z89	5¼	CPM 2.X	Z80	1.12
11-144-02	SuperCalc	IBM DW	8	CPM 86	8086	1.12

SuperCalc^2

List Price $295.00

Part #	Description	Hardware/Format	Disk Size	Operating System	CPU	Version
14-121-52	SuperCalc2	A.B. Dick	5¼	CPM2.X	8085	1.0
14-131-15	SuperCalc2	Apple II	5¼	CPM 2.X	Z80	1.0
14-131-42	SuperCalc2	Behive Topper	5¼	CPM 2.X	Z80	1.0
14-131-04	SuperCalc2	Control Data 110	8	CPM 2.X	Z80	1.0
14-131-55	SuperCalc2	DEC Rainbow/RX-50	5¼	CPM 2.X	Z80	1.0
14-144-55	SuperCalc2	DEC Rainbow/RX-50	5¼	CPM 86	8086	1.0

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Product Availability List (Continued)

SuperCalc2 (Continued) — List Price $295.00

Part #	Description	Hardware/Format	Disk Size	Operating System	CPU	Version
14-131-64	SuperCalc2	Four Phase	5¼	CPM 3.0	Z80	1.0
14-131-27	SuperCalc2	HP 86/87	5¼	CPM 2.X	Z80	1.0
14-144-02	SuperCalc2	IBM DW	8	CPM 86	8086	1.0
14-146-03	SuperCalc2	IBM PC	5¼	IBM DOS	8088	1.0
14-144-05	SuperCalc2	IBM PC-CPM 86	5¼	CPM 86	8088	1.0
14-121-01	SuperCalc2	IBM 3740	8	CPM 2.X	8080	1.0
14-144-01	SuperCalc2	IBM 3740	8	CPM 86	8086	1.0
14-131-47	SuperCalc2	Kaypro II	5¼	CPM 2.X	Z80	1.0
14-131-24	SuperCalc2	MAI-Basic Four	5¼	CPM 2.X	Z80	1.0
14-144-38	SuperCalc2	NEC-APC/3740	8	CPM 86	8086	1.0
14-131-20	SuperCalc2	Northstar	5¼	CPM 2.X	Z80	1.0
14-131-31	SuperCalc2	Uniterm (OKI)	5¼	CPM 2.X	Z80	1.0
14-131-50	SuperCalc2	Osborne One	5¼	CPM 2.X	Z80	1.0
14-131-57	SuperCalc2	Osborne Exec I	5¼	CPM 3.0	Z80	1.0
14-131-48	SuperCalc2	Otrona/Attache	5¼	CPM 2.X	Z80	1.0
14-131-22	SuperCalc2	Superbrain	5¼	CPM 2.X	Z80	1.0
14-121-56	SuperCalc2	TAB	8	CPM 2.X	Z80	1.0
14-144-56	SuperCalc2	TAB	8	CPM 86	8088	1.0
14-146-51	SuperCalc2	TI-Professional	5¼	MS DOS	8088	1.0
14-131-26	SuperCalc2	TVI 800 Series/Televideo	5¼	CPM 2.X	Z80	1.0
14-131-23	SuperCalc2	Vector Graphics	5¼	CPM 2.X	Z80	1.0
14-144-40	SuperCalc2	Victor 9000	5¼	CPM 86	8088	1.0*
14-146-40	SuperCalc2	Victor 9000	5¼	MS DOS	8088	1.0*
14-131-10	SuperCalc2	Xerox 820-I/Xerox-I	8	CPM 2.X	Z80	1.0
14-131-11	SuperCalc2	Xerox 820-I/Xerox-I	5¼	CPM 2.X	Z80	1.0
14-131-12	SuperCalc2	Xerox 820-II/Xerox-II	8	CPM 2.X	Z80	1.0
14-131-13	SuperCalc2	Xerox 820-II/Xerox-II	5¼	CPM 2.X	Z80	1.0
14-131-41	SuperCalc2	Zenith Z89	5¼	CPM 2.X	Z80	1.0
14-131-59	SuperCalc2	Cromemco C-10	5¼	C DOS	Z80	1.0

SuperCalc3 — List Price $395.00

Part #	Description	Hardware/Format	Disk Size	Operating System	CPU	Version
15-146-06	SuperCalc3	IBM PC	5¼	IBM DOS	8088	1.0
15-146-61	SuperCalc3	TI-Professional	5¼	MS DOS	8088	1.0

Product Availability List (Continued)

SuperWriter

List Price $295.00

Part #	Description	Hardware/Format	Disk Size	Operating System	CPU	Version
31-121-01	SuperWriter	IBM 3740	8	CPM 2.X	8080	1.02**
31-144-01	SuperWriter	IBM 3740	8	CPM 86	8086	1.02**
31-146-06	SuperWriter	IBM PC	5¼	IBM DOS	8088	1.02
31-146-61	SuperWriter	TI-Professional	5¼	MS DOS	8088	1.03**

Super SpellGuard

List Price $195.00

Part #	Description	Hardware/Format	Disk Size	Operating System	CPU	Version
32-121-15	Super SpellGuard	Apple II	5¼	CPM 2.X	Z80	2.0
32-146-03	Super SpellGuard	IBM PC	5¼	IBM DOS	8088	2.0
32-121-01	Super SpellGuard	IBM 3740	8	CPM 2.X	8080	2.0
32-144-01	Super SpellGuard	IBM 3740	8	CPM 86	8086	2.0
32-121-20	Super SpellGuard	Northstar	5¼	CPM 2.X	Z80	2.0
32-121-22	Super SpellGuard	Superbrain	5¼	CPM 2.X	Z80	2.0
32-146-51	Super SpellGuard	TI-Professional	5¼	MS DOS	8088	2.0
32-121-26	Super SpellGuard	TVI 800 Series/Televideo	5¼	CPM 2.X	Z80	2.0
32-121-23	Super SpellGuard	Vector Graphics	5¼	CPM 2.X	Z80	2.0
32-121-13	Super SpellGuard	Xerox 820-II/Xerox II	5¼	CPM 2.X	Z80	2.0
32-121-41	Super SpellGuard	Zenith Z89	5¼	CPM 2.X	Z80	2.01

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SuperCalc®, SuperWriter®, Super SpellGuard, are trademarks of Sorcim Corp.

*Two Weeks Lead Time Required before shipment

**Tentative Release Date 2/84.

1/84

SORCIM EDUCATIONAL SUPPORT PROGRAM
TRAINING MATERIALS PRICE LIST
JANUARY 11, 1984

ITEM	PRICE
PRODUCT (SEE ENCLOSED PRODUCT LIST)	$37.50 each
TEN MINUTE GUIDE (TUTORIAL)	1.75 each
ANSWERCARDS (REFERENCE SUMMARY)	.75 each
PRODUCT MANUALS	22.50 each
PRODUCT LITERATURE SUPERCALC3 BROCHURE SUPERCALC3 GRAPH SHEET SUPERCALC2 BROCHURE SUPERCALC BROCHURE SUPERWRITER BROCHURE	7.50/100

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MicroPro®

The Microcomputer Software Company

Educational Pricing for Administrative Use/Bookstore Sales

Product	Suggested Retail	Discount Price
InfoStar	$495	$248
InfoStar Plus	$595	$298
Professional	$695	$348
WordStar	$495	$248
SpellStar	$150	$ 75
CorrectStar	$195	$ 98
MailMerge	$250	$125
StarIndex	$195	$ 98
CalcStar	$195	$ 98
SuperSort I	$250	$125
SuperSort II	$200	$100
StarBurst	$195	$ 98
PlanStar	$695	$348
DataStar	$295	$148
ReportStar	$350	$175

14800 QUORUM • SUITE 345 • DALLAS, TEXAS 75240 • (214) 980-7232

EXHIBIT A

MICROPRO INTERNATIONAL CORPORATION

Education Policy Terms and Conditions

Effective September 1, 1983

QUALIFICATIONS

1. To become an Authorized MicroPro Education Center and qualify for educational discounts, a school, college, university or training institute **must agree not to sell, license, distribute, loan or make copies of our software programs.**
2. An Authorized Education/Training Agreement License requires the completion of and submission to MicroPro:
   - Application for License Agreement (Exhibit B)
   - Education License Agreement (Exhibit C)
   - Student List (Exhibit D)
   - Student Agreement (Exhibit E)
3. A complete description of each course, a copy of the course content, and a copy of any brochures/advertisement must accompany the Application for License Agreement in addition to resumé(s) of the instructor(s).
4. Type of Organization: Educational organization must fit one of the following. Please indicate on application:
   (a) accredited college and/or university
   (b) vocational/trade/technical school
   (c) state/local school system
   (d) other — if organization does not fit a, b or c category, please document qualifications by outlining type of training business, market(s) covered, number of teachers plus resumés, number of students, list of subjects taught and/or client companies, organizations. (See Exhibit B)

MICROPRO INTERNATIONAL CORP., 33 SAN PABLO AVENUE, SAN RAFAEL, CA 94903 USA. (415) 499-1200 TELEX: 278947 MPSR UR

5. Educational Institution agrees to abide by MicroPro's General Terms and Conditions as follows:

Article I: General copying restrictions. Educational User shall not make copies of MicroPro products unless authorized to do so in writing by MicroPro. Unauthorized copying of MicroPro products (including products that have been modified, merged or included with other software) and the acquisition and use of unauthorized copies of MicroPro products may be both criminal and civil offenses for which Educational User may be liable for fines, damages, and attorney's fees.

Article II: Proprietary rights of MicroPro. The MicroPro logo, product name, software manuals, documentation and other support material are either patented, copyrighted, trademarked or owned by MicroPro as trade secrets and/or proprietary information. Educational User agrees not to remove any product identification or notices of such proprietary restrictions from MicroPro products. MicroPro retains exclusive ownership of the MicroPro software, of MicroPro printed materials, and of the MicroPro trademarks. All techniques, algorithms, and processes contained in MicroPro's products or any modification or extraction thereof constitute trade secrets and/or proprietary information of MicroPro and will be protected by Educational User.

Article III: Update Policy. MicroPro may from time to time revise or update its products. Revisions will be provided to Educational Users only if a properly signed Educational License Agreement is on file with MicroPro. MicroPro is not obligated to make any product revisions or to supply any such revisions to Educational User.

Article IV: Transfer Restrictions. Educational User may not loan, rent, sell or otherwise transfer the products or documentation without the prior written consent of MicroPro.

Article V: Termination of Education License Agreement. If any of the terms and conditions of this Agreement are broken by Educational User, in addition to all other legal rights and remedies, MicroPro may terminate this license. Upon termination, Educational User shall return to MicroPro all MicroPro products and copies thereof whether modified, merged, or included with other software, and shall certify in writing to MicroPro that Educational User has not retained any MicroPro products or copies thereof.

Article VI: Governing Law. When entered into the United States, this Agreement shall be interpreted in accordance with the laws of the State of California. Otherwise, this agreement will be interpreted in accordance with the laws of the United States.

DISCLAIMER OF SOFTWARE WARRANTIES AND LIABILITIES

1. MICROPRO SOFTWARE IS DISTRIBUTED AND LICENSED "AS IS". ALL WARRANTIES EITHER EXPRESS OR IMPLIED ARE DISCLAIMED AS TO THE SOFTWARE AND ITS QUALITY OF PERFORMANCE OR FITNESS FOR ANY PARTICULAR PURPOSE. IN NO EVENT WILL MICROPRO BE LIABLE FOR DIRECT, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECT IN THE SOFTWARE.
2. 30 DAY LIMITED WARRANTY ON DISKETTES. MicroPro warrants the enclosed diskettes to be free of defect in material and workmanship under normal use for 30 days after purchase. During the 30-day period, you may return a defective diskette to an Authorized MicroPro Dealer and it will be replaced without charge unless the diskette is damaged by accident or misuse. Replacement of a diskette is your sole remedy in the event of a defect. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.
3. Some states do not allow the exclusion or limitation or implied warranties or liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you.

PRICING (Subject to change)

Individual Product	**Educational Price**
WordStar®	$ 40.00
MailMerge®	$ 30.00
SpellStar®	$ 30.00
CalcStar®	$ 40.00
SuperSort®	$ 40.00
StarBurst®	$ 40.00
PlanStar™	$ 80.00
InfoStar™	$100.00
InfoStar+™	$120.00
StarIndex™	$ 30.00

Packaged Product	**Educational Price**
W/S,M/M,SP/S & S/I (WordStar Professional)	$ 80.00
W/S,M/M,SP/S,S/I,C/S & I/S	$220.00
W/S,M/M,SP/S,S/I,C/S,P/S,I/S & S/B (IBMPC® Format only)	$340.00

There are no additional discounts. Only full product (documentation and disk) is available and one copy **must** be purchased per machine.

GRANTING OF EDUCATIONAL LICENSE

Each application will be considered on its own merits and will be accepted provided all conditions are met.

Field sales representatives or MicroPro personnel will verify number of computers per training site and may conduct audits at any time.

Licenses cannot be granted to organizations where MicroPro's products are being used in an unsupervised environment or in any training organization that offers software rentals in addition to authorized training.

Please note: Only one Education License Agreement is needed to cover an educational organization, but separate application forms (accompanied by student list and agreements) for each course must be filed with MicroPro.

PAYMENT

All orders must be pre-paid in order to ship. Orders submitted without payment will be returned unprocessed.

FREIGHT AND HANDLING CHART

UPS Surface (Brown Label)

The following chart shows the **total** shipping and handling charges for quantities shown in each column. The charges are for shipping via UPS Surface only. If you prefer an alternate method of shipment, please contact your MicroPro sales representative for estimated shipping charges or indicate on your order. All orders that do not include prepaid shipping will be shipped Freight Collect.

UPS CHARGES (Subject to Change)

	1-5	6-10	11-15	16-20
WordStar Professional	$8.25	$16.50	$24.75	$33.00
WordStar	4.75	8.50	13.00	17.75
SpellStar	3.25	5.25	7.25	9.00
MailMerge	3.25	5.25	7.25	9.00
StarIndex	3.25	5.25	7.25	9.00
CalcStar	3.75	6.25	8.75	11.00
InfoStar	8.50	17.00	25.50	34.00

EXHIBIT B

MICROPRO INTERNATIONAL CORPORATION

Application for Education License Agreement
(Complete one application per course)

_____
Name of Education Institution

_____
Street

_____
City State Zip

MicroPro Education License No.: _____

(____) _____ __A __B __C __Other (specify on separate sheet)
Phone Type of Organization

COURSE INFORMATION: Please note that a separate sheet or course brochure may be attached if it is more convenient.

_____
Title of Course

_____
MicroPro Product(s) to be taught

_____
Commencement of Course

_____
Duration of Course

_____
Name(s) of Instructor(s). Please attach resumé(s)

_____
Anticipated number of students

_____
Credit or Non-credit

_____
Number of Microcomputers

_____
Type of Hardware

_____
Cost of Course (if applicable)

FOR INTERNAL USE ONLY:
Approved: _____
Date approved: _____
Type of Organization: __A __B __C __Other

Date received at MicroPro H.Q. _____
FSR verification: _____
Date License Agreement sent: _____
License Agreement #: _____

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EXHIBIT C

MICROPRO INTERNATIONAL CORPORATION

Education License Agreement

Execution of this MicroPro Education License Agreement incorporating Exhibits A, B, C, D, and E, constitute the Education Agreement between MicroPro International Corporation (MicroPro) and

_____
Name of Education Institution

_____
Street

_____
City State Zip

(____) _____
Phone

___ A ___ B ___ C ___ Other (specify) _____

Type of Organization: _____

The undersigned hereby acknowledge that they have read and understood the terms of the MicroPro Education Policy and agree that by signing this document they become parties to the said Agreement and agree to be bound by all terms, conditions, and obligations contained herein.

The terms of this Agreement shall be from _____ 19____ until _____ 19____.

For Education Institution, by:

_____ dated _____
(Must be signed by Senior Administrator)

_____ dated _____
MicroPro Field Sales Representative

_____ dated _____
MicroPro Manager, Education Sales

Contract Exhibits:
Exhibit A: Price List and Terms
Exhibit B: Application for License Agreement
Exhibit C: License Agreement
Exhibit D: Student List
Exhibit E: Student Agreement

INTERNAL USE ONLY

License Agreement No.

_____

MICROPRO INTERNATIONAL CORP., 33 SAN PABLO AVENUE, SAN RAFAEL, CA 94903 USA, (415) 499-1200 TELEX: 278947 MPSR UR

EXHIBIT D

MICROPRO INTERNATIONAL CORPORATION

Education Program
Student List

Name of Education Institution _____

Address _____

_____

Title of Class _____

Number of Students Enrolled _____

Date of Class _____

_____

Name of Student:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____

Instructors: (Required for **each class** in which MicroPro software is taught). Please complete and return to:

MicroPro International Corporation
Education Program
33 San Pablo Avenue
San Rafael, CA 94903

Attach Student Agreements to this sheet.

MICROPRO INTERNATIONAL CORP., 33 SAN PABLO AVENUE, SAN RAFAEL, CA 94903 USA, (415) 499-1200 TELEX: 278947 MPSR UR

EXHIBIT E

MICROPRO INTERNATIONAL CORPORATION

Student Education Agreement

I agree not to make copies of MicroPro Software Programs, as a condition of enrollment in:

_____ at _____

course name — name of school

Name (please print) _____

Signature _____

Home Address _____

_____

Date signed _____

Course Instructor: Please have each student complete an agreement. Attach completed agreements to Exhibit D, and return to:

MicroPro International Corporation
Education Program
33 San Pablo Avenue
San Rafael, CA 94903

MICROPRO INTERNATIONAL CORP., 33 SAN PABLO AVENUE, SAN RAFAEL, CA 94903 USA, (415) 499-1200 TELEX: 278947 MPSR UR

EXHIBIT F

MICROPRO INTERNATIONAL CORPORATION

Education Program
Instructor Agreement

In Lieu Of Submitting Exhibit D (Education Program Student List) and Exhibit E (Student Agreement), Schools May Submit This Agreement, Signed By Each Class Instructor.

I will inform my students that they must agree not to make copies of MicroPro software, as a condition of enrollment in _____.

I will use the following method to inform my students of their responsibility in regard to copyright law:

____ Teach a course module on copyright law and software user responsibility.

____ Include a statement on student responsibility with class materials.

____ Post a sign in the classroom.

____ Other (please describe) _____

_____

_____

(Please attach any student notices or agreements that you distribute to students regarding software copyright protection.)

Name (please print) _____

Signature _____

School _____

Date Signed _____

Appendix B

IBM AND ITS PERSONAL COMPUTER

Today, the microcomputer market is ablaze with the fires of change. These fires are being fanned by the entrance, into the personal computer market, of the computer industries production and service giant, IBM. BYTE magazine reports:

> In the early 1900s, IBM, then called the Computing-Tabulating-Recording Company (CTR), leaped from obscurity by automating the US census with a device known as the Tabulating Machine. In 1983, IBM appears poised to make another quantum leap by automating everyone from Fortune 500 executives to gradeschool children. The vehicle for this revolution? The great-great-grandchild of the original CTR Tabulating Machine--the IBM Personal Computer.[1]

IBM must be credited with revolutionizing the microcomputer market with the introduction of its personal computer, the IBM PC in September, 1981. The unveiling of this particular model was not in itself a revolutionary act, but rather, the marketing approach that IBM has taken revolutionized the microcomputer industry. In creating the IBM PC, IBM's marketing approach can be simplified to three major design requirements: 1) Build a personal computer that used state-of-the-art components but one that did not create a whole new set of standards for the microcomputer

industry. IBM sought to move into an already well developed microcomputer marketplace taking advantage of available software and hardware. 2) Build a personal computer that used an "open architecture philosophy". IBM realized that no single supplier of software or hardware could provide the totality of function desired by the wide variety of customer-oriented requirements. 3) Build a personal computer that did not have build in obsolescence. IBM sought to further the markets pioneered by other microcomputer manufacturers with the outlook of simplicity with a future. That is to say, a durable product that would fit the customer's most basic initial requirements but allow for enough capacity and power that it had the capability to be expanded. Additionally, IBM wanted its personal computer to remain a competitive force in the marketplace during the next decade.

Based on the first design requirement, the IBM design team chose to stay with the 8-bit I/O architecture. Although IBM believed this to be a limitation to their main processor, this trade-off was made to better adapt the IBM PC to the present marketplace. Also, because of the world-wide use of Microsoft Basic, IBM chose to develop its operating system software around MS-DOS. IBM labeled its operating system PC-DOS which according to BYTE magazine is; "Microsoft's MS-DOS in disguise".[2] The magazine goes on to state that; "MS-DOS is currently the fastest growing of the

leading operating systems. We expect that by late 1984 or early 1985, MS-DOS will have the largest library of applications".[3] Along with this consider what Consumer Reports has to say:

> MS-DOS stands for Microsoft Disk Operating System, the trademarked system chosen by IBM when it introduced the IBM-PC. In the IBM-PC, the system, somewhat modified, is called PC-DOS.
>
> Whatever the name of the DOS, it's the name of IBM that guarantees a market for software publishers.[4]

It can be clearly state that, based on IBM's staunch reputation and the growing application library that is rapidly developing for its personal computer, the IBM-PC will definitely play a major role influencing the direction the microcomputer industry will take in the next three to five years.

IBM's second design requirement lead to an "open system" concept. The third party vendors were provided with hardware and software design standards upon which they could produce application software and hardware enhancements for the IBM-PC. This was a unique marketing approach when compared with other microcomputer manufacturers. Again, this approach was taken based on IBM's belief that no single vendor could meet the variety of needs desired by the wide variety of customer-oriented requirements. Frank Gens and Chris Christiansen, in their article: Could 1,000,000 IBM-PC Users Be Wrong, states;

> The activity that the PC has stimulated in the third party world has been spectacular. For example, we estimate that approximately 10 new PC products from both IBM and third party vendors are announced daily. IBM estimated that as of mid-1983, at least 3,000 hardware and software products from 2,500 vendors were available for the PC, compared with 1,250 products in mid-1982. And this number is expected to grow to more than 6,000 by the end of 1984.[5]

Should these facts prove to be true, IBM's personal computer will have software documentation and hardware support that is second to none in the microcomputer marketplace. This marketing philosophy should allow the customer the system design flexibility and support required for almost any imaginable application.

The Intel 8088, 16-bit processor was chosen to counter balance the simplicity of the machine and yet provide a product with durability as well as enough power and capacity to grow, thus meeting the third design requirement. Philip D. Estridge, president of the IBM Entry Systems Division in Boca Raton, Florida, says that the Intel 8088 was a fortuitous choice; "It happened to be there when we needed it to introduce the power of a 16-bit computer and keep the affordability of the 8-bit I/O (input/output) architecture".[6] IBM now provides a matched set of Intel's 8088, 16-bit processor, and 8087, coprocessor. Estridge reports; "the newer 8088s have slightly different characteristics that result in better performance of the

8087 coprocessor. By shipping both processors we know that the customer will get the best possible performance from the 8087".[7] BYTE magazine sees this combination of processors as "being kind of an extra turbocharger that the drag-racing set will like".[8]

Since its introduction, the IBM PC has dominated the microcomputer market. Software and hardware continue to grow at a phenomenal rate and so does IBM's share of the total sales for microcomputers between the range of $1,000 and $10,000. In fact, among the top three microcomputer manufacturers, (Apple, IBM, Tandy), IBM has, since the introduction of its IBM PC, quickly taken over a lion's share of the market and is projected to hold these gains. See Figure 1 for comparison of shipping data among the top three microcomputer producers.

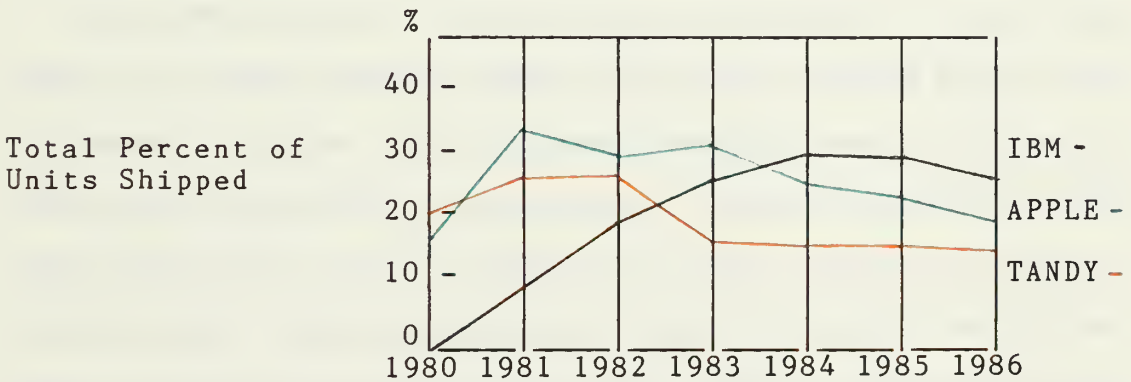

FIGURE 1: This chart depicts shipments of business-oriented desk-top computer systems costing between $1,000 and $10,000 shipped in North America. Percentage is total of all units shipped. The last three years are projected percentages based on present market forecast.

IBM has quickly captured a large share of the North American market with the introduction of its personal computer. As yet, it remains to be seen what IBM's personal computer will do in the international market. However, there is evidence that IBM will go after a share of that market. In mid-March of this year IBM introduced the first of its personal computers into the Japanese market. It is one of the first computers, priced under $10,000, to provide high performance word processing using the Japanese characters, Kanji. This introduction of IBM's personal computers in the world markets demonstrates that the corporate structure at IBm has come to realize the importance and future of the personal computer in all walks of life and IBM wants its share of these markets.

The IBM personal computer is available in two basic models in North America, the IBM PC and the IBM PC XT. The XT model extends the storage capacity and information handling capability of the IBM PC. Inside the XT you find eight expansion slots, compared to five expansion slots in the PC model. These additional slots were added to correct the customer generated complaint that the PC had too few slots. The main difference between the XT and the PC models is that the XT has had one of its floppy diskette drives replaced with a 10 Megabyte fixed disk drive. Rowland

Archer reports that:

> The hard disk contains two platters, for a total of four writable surfaces. Each surface contains 306 tracks; each track has seventeen 512-byte sectors, for a total storage capacity of 10,653,696 bytes. Although this is a lot of storage compared to most floppy-disk-based systems, I was surprised at how fast I filled up half the disk.[9]

With an optional expansion unit the PC and XT models can be expanded to contain two floppy diskettes with 360K bytes of storage and two hard disks with 20M bytes of storage. This produces a very powerful system for handling and transferring data from either type of storage. The total cost for the XT system with the expansion unit would cost around $10,000. This may seem a large sum but compare it to the cost of a system developed by IBM in 1975, the IBM 5100. This system sold for $19,975[10] which included 64K bytes of user memory and a magnetic tape cartridge storage device that was capable of holding up to 204,000 characters of information. One could purchase an auxiliary tape for an additional $2,300[11]. Obviously, the success of IBM's personal computer, and for that matter the microcomputer industry as a whole, has been due to the capability of manufacturers to reduce the cost of system components. If the declining cost trend continues, as it is forecasted to do, it will know doubt ensure that the personal computer will become as common to all of us as the telephone or

color television have become.

The IBM PC system sells for $3,400. This includes two 360K byte diskette drives, monochrome display, keyboard, 64K bytes of RAM, and DOS 2.1 (the PC DOS operating system). To convert the system to color graphics would require an additional $400 and exchange of the monochrome display for the color monitor.

The IBM PC XT system sells for $6,000. This includes one 360K byte diskette drive, one 10M byte fixed disk drive, monochrome display, keyboard, 128K bytes of RAM, and DOS 2.1. Cost of conversion to color and graphics capability remains the same as the IBM PC system previously listed.

IBM system costs provide substantial computing power for the dollar. Additionally, because so many vendors have joined the race to provide customer support for IBM's personal computers, careful shoppers will find substantial savings available when buying the initial system or redefining a present system. An important product of the hardware vendors is the multifunction board. These boards can contain, additional memory, high speed disk emulators, parallel ports, serial asynchronous ports, extremely accurate chronograph (clock/calendar), buffer/spooler, and dealer specials such as the capability to swap printers, from say a dot-matrix printer to a letter quality printer, which are both connected to the same computer. PC THE BUYER'S GUIDE list many of these boards with varying

prices. One of the more elaborate boards available is the Easiboard™ which includes all the functions mentioned above, and retails for $595[12]. This price is very competitive when you consider that memory alone, from IBM, is priced at over $1,000.

Documentation for the IBM line of personal computers has reached unprecedented proportions. Bookstores, computer outlets, and magazine stands contain explanations and hints that tend to inundate the average consumer. What accurate, straightforward, inexpensive document should the novice use to base purchase decisions on? Even the computer "expert" can become intimidated by the amount of information that shouts in his face. Today, as IBM's share of the market grows, many computer analysts are concerned that IBM may become the present and future standard for the microcomputer industry the way the IBM large mainframe computers are, thereby stunting creativity and expansion of the microcomputer market. Still, others argue that this new era of IBM has set a standard for the microcomputer market and stabilized a volatile environment where many consumers were afraid to enter. These points will be hotly debated over the next year or so. Technocrats will also continue to argue the advantages and disadvantages of the IBM personal computer against its market counterparts. Whatever the merit of these articles and discussions, they provide plenty of information to assist the consumer in making an

intelligent decision on whether the IBM line of personal computers will meet the user's needs.

In conclusion, the IBM personal computer is an advanced machine which is competitively priced. It offers some of the latest technology in its 16-bit processor, yet uses the market standards in its input/output devices. It has been designed to meet a multitude of consumer requirements in a variety of ways. The software, hardware, and service support is guaranteed by the mere fact the microcomputer carries the IBM name. Also, third party vendors have flocked to provide more support for the IBM personal computer than the microcomputer industry has ever seen before. The sheer output of these small businesses has become a major industry in itself. IBM has recognized the consumer demand for small computers and has adjusted their corporate structure to meet this demand. All of these facts have had a stabilizing influence on the microcomputer industry and assures the wary consumer that this particular computer system has a future.

It should be noted that since this report was developed in November of 1983, AT&T has introduced its version of a personal computer called the, what else, AT&T PC. This computer uses a close relative of the IBM's microprocessor, the Intel 8086. The AT&T microcomputer system can utilize PC DOS programs and has a full 16-bit data path with an 8MHz clock speed, thereby speeding up operations considerably

when compared to the IBM PC. The AT&T PC is comparably priced to the IBM PC. Even though AT&T has utilized a later generation microprocessor than IBM originally used, it looks as though AT&T, along with other microcomputers such as Compaq, Eagle, TI, and many other clones to numerous to mention, will follow IBM's lead and continue to produce software and hardware that is IBM PC compatible. This should give some indication of just how solid a hold IBM and its personal computer has on the microcomputer market!

NOTES

[1] Gens, F. & Christiansen C., "Could 1,000,000 IBM-PC Users Be Wrong?", Byte Magazine, November 1983, p. 135

[2] Ibid., p. 138

[3] Ibid., p. 138

[4] "Computers", Consumer Reports, October 1983, p. 469

[5] Gens, F. & Christiansen C., "Could 1,000,000 IBM-PC Users Be Wrong?",Byte Magazine, November 1983, p. 138

[6] Curran, L.J. & Shuford, R. S., "IBM's Estridge", Byte Magazine, November 1983, p. 88

[7] Ibid., p. 92

[8] Ibid., p. 92

[9] Archer, R., "The IBM PC XT and DOS 2.0", Byte Magazine, November 1983, p. 294

[10] "Welcome, IBM, to Personal Computing", Byte Magazine, November 1983, p. 137

[11] Ibid., p. 137

[12] Bonita E. Taylor, ed., PC THE BUYERS GUIDE, (New York: Ziff-Davis Publishing Co., 1983), p. 12

Thesis
H1128 Hague
c.1 Microcomputers and
the Electrical Engineer.